Vol 15 No 3 Aug 1974

AIR FORCE
Civil Engineer

FIRE PROTECTION

PEOPLE: The Key

EQUIPMENT: Second to None

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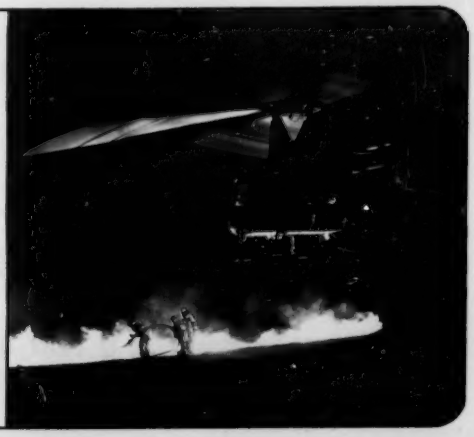
THE CHALLENGE: Civil Engineering Must Take the Lead



AIR FORCE Civil Engineer

USAF RECURRING PUBLICATION CE 85-1 VOL 15 NO 3 AUGUST 1974

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IN THIS ISSUE

Current Emphasis	1	
Air Force Fire Losses	3	
The Key to Fire Prevention: People	4	by Maj Gen Billie J. McGarvey, PE
Air Force Fire Fighting Equipment: Second to None!	5	by Maj Willet R. Stallworth
Air Force Civil Engineering Must Lead the Way	8	by Lt Col Anthony M. Vitale
The Road to Riches	10	by Bernard C. Meredith, PE Robert E. Jamison, PE
A Hierarchy of Civil Engineering Objectives	13	by Capt Palmer G. Arnold Capt Richard E. Ducharme Capt David F. Fink
Worth Noting	17	
When Feathers Are Ruffled, Drop Your Hook	18	by Col Morris B. Rubenstein, PE
One Step Turnkey Housing: The Cannon Experience	21	by Maj R. Wayne Bateman Thomas L. Lord, PE
Removing Harmful Grease and Oils from Sewer Systems	24	by John L. Goforth, EIT
Letters to the Editor	27	
Xenia Tornado Disaster	28	

The **AIR FORCE CIVIL ENGINEER** is an official nondirective Headquarters US Air Force publication published quarterly under provisions of Chapter 2, **AFM 5-1.** Its purpose is to provide Air Force Civil Engineers with a timely and comprehensive picture of the importance, wide ranging involvement and direct relationship of civil engineering activities to successful accomplishment of the Air Force mission. It provides current information about significant civil engineering programs and accomplishments throughout the Air Force; pertinent developments in science engineering and management; and educational/training opportunities for enhancing professional thought and development. The Journal is edited and published by the Civil Engineering School, Air Force Institute of Technology. Contributions, suggestions and criticism are welcome. Opinions expressed do not necessarily reflect the official viewpoint of the Department of the Air Force, the Director of Civil Engineering or the editorial staff. DISTRIBUTION: F. The Journal's annual subscription prices are: $2.10 domestic: $2.70 foreign.60 cents per copy. Mail check or money order to Superintendent of Documents: Government Printing Office, Washington, D.C. 20402.

Address Correspondence to: Editor, Air Force Civil Engineer, AFIT-DE, Wright-Patterson AFB, Ohio 45433

Current Emphasis

Information published here is designed to keep civil engineering personnel aware of late developments and significant trends within the career field.

ENERGY CONSERVATION PROGRAM--A 16 percent reduction in installation utilities total energy was achieved during the third quarter, FY 1974. This conservation exceeded the DoD-established 15 percent reduction goal for the period 1 January - 30 June 1974. In general terms, the Air Force conserved the equivalent of 1,050,000 barrels of fuel oil during this time frame. The cost to purchase this amount of fuel oil at 1 April 1974 prices would have been nearly $15 million.

FAMILY HOUSING SELF-HELP STORES--Fourteen bases from Germany to Okinawa are evaluating a spinoff of the self-help concept. A selected stock of easy-to-install items is available for family housing occupants to use in performing tasks which otherwise could consume Base Civil Engineer labor. Results will be consolidated after six months of testing, and a decision made as to further implementation.

ASSESSMENT OF ENVIRONMENTAL IMPACT OF REAL ESTATE ACTIONS--The impact of real estate actions on the environment should be assessed during the initial stages of identification of the requirement. This pertains to all types of real estate actions including lease renewals. Early identification of environmental impact is necessary in case a full environmental impact statement is required.

GAS LEAKS COST MONEY--Five to 10 percent of natural gas may be wasted at an installation due to undetected gas leaks. An annual gas leakage survey should be part of any good maintenance program. AFM 91-6, paragraph 5.5, gives guidance on conducting surveys in-house or they may be conducted by contract for a nominal cost.

FAMILY HOUSING IMPROVEMENTS--A total of 2,150 housing units are being upgraded and repaired at Eglin Field 9, Florida; Kincheloe AFB, Michigan; Cannon AFB, New Mexico; Wright-Patterson AFB, Ohio; Kelly AFB, Texas; and Ramstein AB, Germany. Total cost is $16 million. An additional $20 million worth of improvements at other bases is being designed.

COMPUTER ASSISTED INSTRUCTION--Sheppard Technical Training Center Computer Technology Branch, working in conjunction with the Air Force Data Systems Design Center civil engineering functional area, is developing automated BEAMS programmed learning lessons for use at base level on the TC521 remotes. Course I lessons in the operation and maintenance of the cost accounting, labor and Prime BEEF, work control and real property subsystems and use of associated products, are scheduled for December 1974 release to all BEAMS bases. Lessons for standalone subsystems (Course II) are tentatively planned to be released in June 1975.

NEW AFR 92-1--Major air command fire protection specialists/engineers and base fire chiefs must implement an immediate program to realign their overall fire protection posture to meet the new requirements of AFR 92-1.

OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) STANDARDS--are now available through the Publications Distribution Office (PDO). It is imperative that Base Civil Engineering organizations submit their requirements to their local PDOs to obtain a minimum of one set for their reference libraries. AFR 127-12 requires that all OSHA standards be reviewed to determine if there are inconsistencies between safety and health standards in Air Force publications and the OSHA standards. In many instances, the OSHA standards will be incorporated into Air Force publications verbatim. When incorporated, the OSHA standards will lose their identity and become Air Force standards, and will be applicable to federal employees. Contractors, whether working on or off Air Force facilities, must comply with OSHA standards.

NATURAL RESOURCES CONSERVATION--Comprehensive plans for fish and wildlife and outdoor recreation resource management are under preparation for all installations. New emphasis is placed on management of game and non-game animals, protection of rare and endangered species and non-consumptive use of outdoor recreation resources. Approved plans along with signed fish and wildlife cooperative agreements are required by 22 February 1975. Contact USAF/PREV, Autovon 227-2030, for technical assistance.

ADDITIONAL GUIDANCE ON AICUZ--Guidance was recently issued to implement an Air Force Air Installation Compatible Use Zone property acquisition policy. This policy enlarges existing Clear Zones and allows for the acquisition of real property interests by purchase or land exchange to prevent certain incompatible land uses.

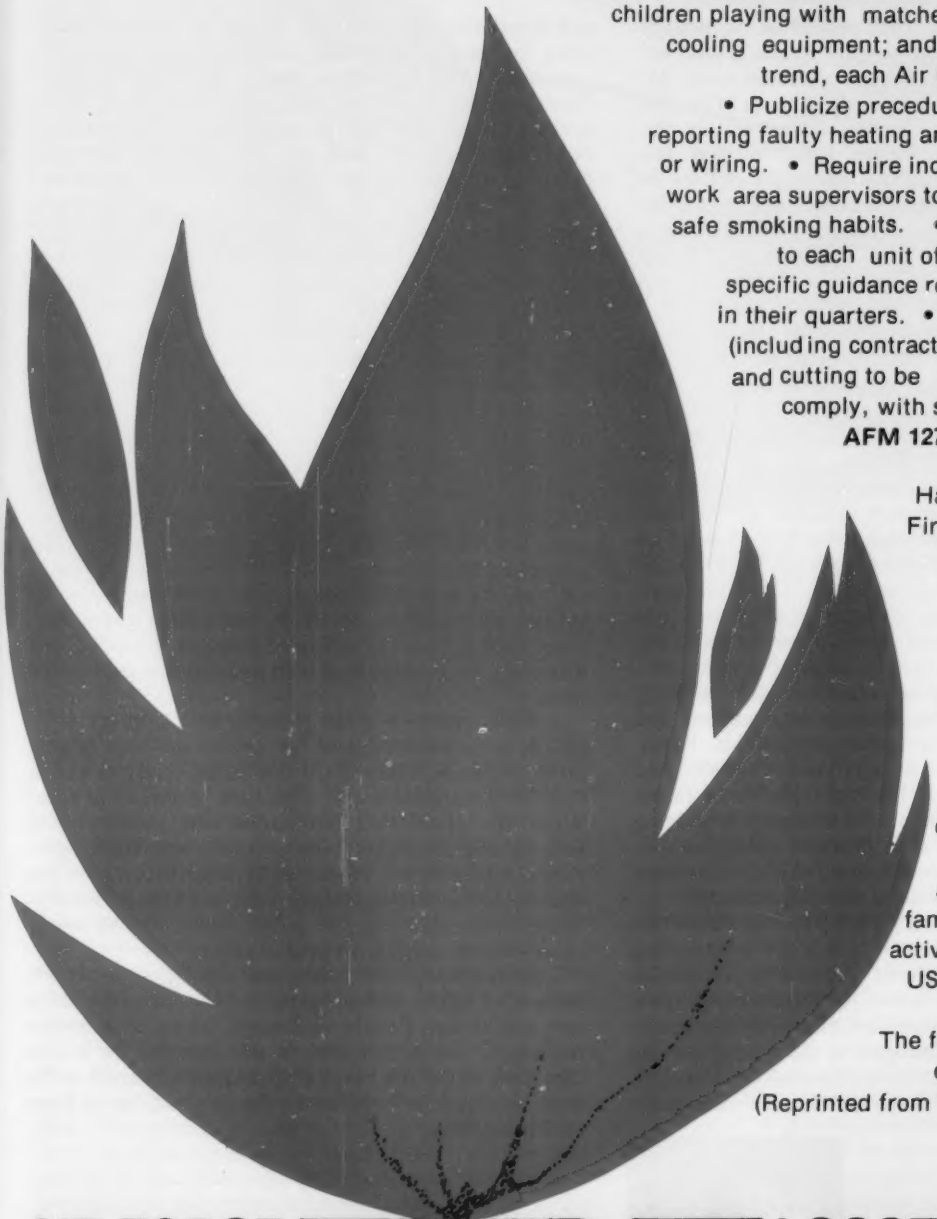
HOMES FOR LOWER GRADE AIRMEN--A request before Congress is pending to construct two-bedroom homes for airmen, E-1 through E-4 with less than two years service. This program is targeted to construct 800 homes at six US bases and one overseas location in the FY 1975 Multi-Family Housing Construction Program. Design is in progress and contract award for construction is scheduled to occur in the spring of 1975.

AFIT MASTER DEGREE PROGRAMS--Facilities Management, a 12 month quantitative and qualitative management program, and Civil Engineering Facilities, a 15 month multidisciplinary civil/mechanical/electrical engineering program, are accredited master degree programs offered through AFIT resident schools. For information on obtaining one of the 20 yearly quotas for each course, contact the AFIT admissions office, your local education office or PALACE BLUEPRINT.

ENDANGERED SPECIES--The Endangered Species Act of 1973 requires a higher degree of protection for species of plants and animals which are in jeopardy in the US and around the world. The Act establishes two categories of species subject to protection: threatened species and endangered species. Under the Act, military installations shall carry out programs for conservation of endangered and threatened species in consultation with and assisted by the Department of the Interior. All actions authorized, funded and carried out must not jeopardize these critical species.

HOMES FOR SENIOR ENLISTED PERSONNEL--A new grade category for Senior Enlisted Personnel, E-7 and above, has recently been authorized by Congress. Public Law 93-166 now authorizes the Air Force to construct homes for personnel in this category that are up to 25 percent larger than previously authorized.

APPLICATION OF BCE MANPOWER STANDARDS--An AF/PREM ALMAJCOM letter, dated 12 February 1974, rescinded the plus or minus 10 percent range factor when applying BCE standards. Actual, on-line computations will be the only method used in application exercises.



AIR FORCE FIRE LOSSES

Air Force fire losses for Fiscal Year 1974 approximated $4 million. The largest number of incidents continued to occur in military family housing; however, significant dollar losses also have resulted from fires involving other areas, such as dining facilities, hangers, clubs and warehouses. The causes continue to be faulty heating and electrical equipment; careless smoking habits; improper welding and cutting practices; children playing with matches; unattended and faulty cooling equipment; and arson. To reverse this trend, each Air Force installation must:

• Publicize precedures for recognizing and reporting faulty heating and electrical equipment or wiring. • Require individual commanders and work area supervisors to brief their personnel on safe smoking habits. • Publish, and distribute to each unit of military family housing, specific guidance regarding fire prevention in their quarters. • Require base personnel (including contractors) involved in welding and cutting to be thoroughly familiar, and comply, with safe practices outlined in **AFM 127-101,** "Industrial Safety Accident Prevention Handbook," and National Fire Protection Association Pamphlet No. 51.

• Require each fire incident — regardless of size or loss — to be investigated thoroughly and, where appropriate, initiate disciplinary or pecuniary action.

It is essential that commanders, individual work area supervisors, and sponsors of military family housing, participate actively in, and support, the USAF base fire prevention program.

The fire prevention inspector cannot do the job alone!

(Reprinted from **TIG Brief,** 24 May 1974)

From the Director

The Key to Fire Prevention: People

To the average person, fire protection is usually symbolized by the bright red fire and crash/rescue vehicles with flashing lights such as we see on every Air Force base. Too often, in the minds of many, this picture represents total fire protection. Unfortunately, the business of safeguarding the Air Force mission, the lives of its members, and the countless dollars in property and material from the ravages of fire is a far more complex problem. Fire prevention and protection are a big part of the Base Civil Engineer's job, yet full responsibility belongs equally to each Air Force member, each dependent and each civilian employee.

Civil engineering efforts to provide the best possible fire protection are readily evident today. We have made needed changes in fire apparatus allowances; new extinguishants are constantly being tested and put into use; and the aging fleet of fire vehicles is being totally replaced by a new generation of fire fighting equipment. Modern structural pumpers, crash fire fighting and crash support vehicles, all with improved capabilities, are reaching the field daily. Fire extinguishing agents or chemicals are under continued study and the current practice of providing the most effective agents to our many fire departments is a firm policy. Improved use of manpower through redistribution of our fire fighter assets is expected soon. Adequate manpower, fully trained and utilized in the proper jobs, will improve fire department management and add significantly to fire protection capabilities. Further, our continued push for recognition of the skills and professionalism required of our individual fire fighters has resulted in establishment of a Category A training program for fire fighters. New entrants to the fire service will now have the needed basic skills before they are assigned to an installation fire department.

Our recently published **AFR 92-1,** Fire Protection Program, is a straight-forward guide for establishing and maintaining the total Air Force Fire Protection Program. It provides sufficient user latitude to meet local problems and otherwise impractical or impossible conditions. Redundant verbage (the main complaint on proceeding directives) has been essentially eliminated. On the contrary, Aircraft Crash/Rescue Assistance and Evaluation Teams, are providing on-site assistance for solution of problems in base fire department operations, training, management, and base support. These teams are assigned to the Air Force Civil Engineering Center and they operate under the direction of the Fire Protection Officer: Headquarters US Air Force. In addition to unannounced visits to the bases, they provide service through evaluation of fire protection program performance and in-depth direct assistance in program improvement. In yet another area, we are working to provide fire protection that will meet individual hazards presented by each type of facility. Engineered plant protection and construction criteria developments are forthcoming which will provide even better fire protection for less cost.

Last, but certainly most important, is fire prevention. Obviously, prevention is the best form of protection and all of the actions above include some element designed to prevent the occurrence of fire or limit its spread once it does occur. New facilities and housing today are relatively safe from fire—people now are the remaining element of greatest fire hazard. This hazard can only be reduced through safe work and personal habits, attention to detail in hazardous processes, proper storage and handling of flammable liquids and materials, and compliance with general fire prevention rules.

While common sense prevails as a primary safeguard, some knowledge of fire causes and fire behavior is necessary. Here too, we must be ready to assist. The fire departments also offer both general and specialized fire prevention information and instructions in first-aid and fire fighting. In addition, base fire inspectors assigned to the Technical Services function of the fire department periodically visit each base facility. They come as advisors to point out hazardous conditions and to suggest remedial action.

In summary, we have come a long way, yet the danger of injury and property loss by fire remains a very real threat. People—informed, aware people—are the key to fire prevention. In this interest we devote this issue of the **Air Force Civil Engineer** journal to the ever timely, ever important subject of fire prevention and protection.

Billie J. McGarvey

BILLIE J. MCGARVEY
Major General, US Air Force
Director of Civil Engineering
Headquarters US Air Force

Modern fire service has become a highly complex job of managing professionally trained men and sophisticated equipment that are essential to the success of today's Air Force mission. The following is a report on . . .

Air Force Fire Fighting Equipment: Second to None!

by Maj Willet R. Stallworth

Modern fire service as we know it today began some 60 years ago with the complete adoption of mechanized apparatus. While the military fire service does not enjoy quite the same lengthy history as its civilian counterpart, there has been a similar evolution of tactics and equipment. The simple routine of the old-time chief who had a few pumpers and men has changed to the highly complex job of managing professionally trained men and sophisticated equipment that are essential to the success of today's Air Force mission.

Fire fighting has become a new art since World War II. Tactics and equipment developed were primarily geared toward structural fire fighting. Since then, the advent of larger, higher performance aircraft, sophistication of aerospace fuels, and the complexity of the materials and equipment necessary to perform the Air Force mission have made past fire fighting methods and equipment obsolete. Changes have been vast and significant in all areas; however, as with all evolutionary or growth processes, the very great degree of change is seldom noticed in day-to-day scrutiny. Not only have changes improved the degree of protection provided to Air Force resources, but they have provided fire fighters a safer environment within which to work as well.

Aircraft fire fighting and rescue equipment research and development is the responsibility of the Department of Defense Tri-Service Aircraft Ground Fire Suppression and Rescue Systems Project Office which, in concert with the Air Force Civil Engineering Center, provides the necessary operational test and evaluation of new equipment. Through efforts of these two agencies and from suggestions from individual fire fighters, numerous changes have been made in the equipment available.

Vehicular fire fighting equipment is allocated to bases according to the fuel load of aircraft and the base mission. Eight different combinations of vehicles are possible. Vehicles within the sets were recently realigned to provide a more equitable distribution of assets as a result of an extensive study of fire protection requirements conducted by the Air Force Civil Engineering Center. Vehicle sets are comprised of various combinations and numbers of nine different vehicles. Vehicles such as the A/S32P-2 crash vehicle, 0-11A/B crash vehicle, 0-6 carbon dioxide crash vehicle, 1500 gallon water distributor, F-6/F-7 runway foamer, and the P-6 pickup ramp patrol vehicle have been in the inventory for the past 10 years. Recent additions to vehicle sets include:

cont'd on next page

Equipment *cont'd*

A/S32P-4 Crash Vehicle: This multi-purpose crash/structural fire fighting vehicle is being introduced to replace the aging 0-11A/Bs. The vehicle is air transportable and is designed for use in a bare base environment. Additionally, it offers an articulated frame and carries 1500 gallons of Aqueous Film Forming Foam (AFFF). As of 1 June 1974, 147 vehicles had been delivered. By the end of FY 75, 474 vehicles will be in use throughout the Air Force.

A/S32P-8 Structural Pumper: This is a replacement vehicle for the current 530A/B structural type vehicles. By the end of FY 75, 359 of these 500 gallon per minute brush and structural fire fighting vehicles will be in service.

A/S32P-10 Rescue Vehicle: Built on a 3/4 ton pickup frame, this crew cab vehicle transports a three-man rescue team and necessary rescue equipment to cope with almost every conceivable emergency situation. It will replace the present R-2/R-2A.

A/S32P-8 STRUCTURAL PUMPER—A replacement for the current 530A/Bs, 359 of these 500 gallon per minute brush and structural vehicles will be in service by the end of FY 75.

A/S32P-12 Structural Pumper: Replacing the Class 750A structural pumpers which have been in the Air Force inventory for some 19 years, this new vehicle is an improved version of the older vehicle. As of 1 June 1974, 125 vehicles were in service. A total of 312 of these vehicles are scheduled for use throughout the Air Force by the end of FY 75.

A/S32P-13 Ramp Patrol Vehicle: This 3/4 ton pickup is equipped with 507 pounds of Halon 1211 chemical and 350 pounds of dry chemical extinguishing agents. Primary use of the vehicle is for patrolling airfield ramp areas to provide quick response to aircraft and ramp type emergencies. By the end of FY 75, 420 vehicles will be in use.

A/S32P-15 Large Capacity Vehicle: Intended for use on bases with large frame aircraft, this vehicle carries 6500 gallons of agent. The initial vehicle is in operational use at Travis AFB, California. First article vehicles are being procured for operational tests during FY 75.

MAJOR STALLWORTH *is Chief, Engineering Equipment Division, Air Force Civil Engineering Center, Tyndall AFB, Florida. He also is the Team Chief of the USAF Aircraft Crash Rescue Field Assistance and Evaluation Team. He received his bachelor's degree in civil engineering from Texas A&M University and his master's degree in counseling and guidance from Troy State University. He is a member of the Society of American Military Engineers.*

Perhaps the most significant development in aircraft fire fighting has been in the area of improved extinguishing agents. Aqueous Film Forming Foam, or AFFF as it is more commonly known, was introduced in 1970 after extensive testing as a replacement for protein foam. The new agent is three times as effective as protein foam in controlling and holding fuel fires. In addition to its improved extinguishing characteristics, AFFF has the added advantages of eliminating fire flashbacks, it is a clean agent, and does not have the noxious smell of its predecessor. AFFF is now used throughout the Air Force as the primary extinguishing agent in all crash equipment.

Other auxiliary agents have undergone tests and evaluation in a continuing effort to identify more effective agents. Of the agents tested, dry chemicals and Halon 1211 have proved most effective and are now being used in initial response to small scale electrical and engine fires. Additional agent tests scheduled for FY 75 will investigate the effects of clean agents in aircraft engines and evaluate replacement agents for chlorobromomethane fire extinguishers which have been identified as hazardous by the Occupational Safety and Health Act.

Basic fire fighter equipment also has undergone a similar though more subtle change. Communications have been vastly improved with the addition of multichannel radios to all fire vehicles. Hand-held portable radios have provided a flexibility and capability heretofore not possessed, particularly in rescue from large frame aircraft and in smoke filled buildings. Tests are currently underway on a hood mounted communication device that frees fire fighters' hands and further improves control and safety during emergencies.

Other personal equipment improvements include the testing of lightweight aluminized protective cloth-

A/S32P-15 LARGE CAPACITY VEHICLE—Intended for use on bases with large frame aircraft, this vehicle carries 6500 gallons of agent. Travis AFB has the initial vehicle.

ing. In addition to improved protection, the new clothing weighs only 14 pounds, a reduction in weight of 15 pounds over current models.

Test of a water spray smoke suppression system will be conducted at Chanute AFB, Illinois, and may have a significant impact on the quality of training provided future fire fighters. The prototype system was designed to provide realistic live fire training without the pollutants of current training fires. If the prototype proves successful, similar units will be planned for bases throughout the Air Force.

HIGH REACH VEHICLE—Testing is underway at Kelly AFB, Texas to determine the requirements for vehicles of this type.

A/S32P-4 CRASH VEHICLE—Introduced to replace the aging 0-11A/Bs, this multi-purpose crash/structural fire vehicle is air transportable and designed for use at a Bare Base.

The Civil Engineering Center is testing a powered aircraft skin penetrator/agent applicator developed by Aeronautical Systems Division (ASD) for use in rescue and fire fighting in unaccessible areas of an aircraft. Other tests and developments include improved foam systems and nozzle designs to optimize agent application; turret control systems for better visibility in a fire environment; improved fire fighter breathing apparatus and recharging compressor/purifier; development of a diesel engine for P-2 fire vehicles; maintenance; evaluation projects for improved rescue equipment; and radio fire alarm detection systems. At the time of this writing, the above projects were nearing completion and are expected to be available to the field in the near future.

Studies are also underway to identify a replacement vehicle for the F-6/F-7 runway foamer. The proposed vehicle, designated A/S32P-14 Runway Foamer/Resupply Vehicle, will have a 5000 gallon capacity and afford both protein foam for runway foaming and AFFF for use as an auxiliary fire fighting vehicle.

Operational testing is underway at Kelly AFB, Texas, to determine the feasibility and requirement for a high reach fire truck for use in fire fighting and rescue from multi-story/large size buildings. Should the tests prove favorable, individual bases with sufficient multi-story/large frame buildings would be able to obtain the high reach vehicle.

Development and testing of new and improved equipment does not just happen. Suggestions by individual fire fighters, fire chiefs and major air command representatives have helped identify needed improvement areas. Active support by Civil Engineering Equipment Advisory Group and Aircraft Crash Rescue Field Assistance Evaluation Teams, plus the concerted efforts of the Civil Engineering Center, ASD, and Warner Robins Air Logistics Center have all played key roles in improving the fire fighting equipment posture of today's Air Force, equipment that is second to none. CE

A/S32P-13 RAMP PATROL VEHICLE—Primary use of this 3/4 ton pickup is for patrolling airfield ramp areas to provide quick response to aircraft and ramp type emergencies. By the end of FY75, 420 vehicles will be in use.

Fire prevention is an essential part of the Air Force mission. Since responsibility for providing fire protection for base facilities lies with Base Civil Engineering, it must impress upon every Air Force member and employee the dangers of fire, its cause and effects.

Air Force Civil Engineering Must Lead the Way

Lt Col Anthony M. Vitale

Air Force fires, as other accidents, don't just happen. They are caused. While the causes may be classified from complex to simple, most are listed in the latter category. A few actual examples of fires that occurred during Fiscal Year 1974 follow:

- A civil engineering craftsman disregarded normal safe work procedures during a cutting torch operation to remove old plumbing and kitchen equipment from a building. Hot slag dropped into a wall cavity and fire quickly erupted. The presence of a noncombustible shield to catch and hold the hot slag or an alert fire guard could have prevented the ensuing fire.
- In another instance, faulty and improperly maintained heating equipment resulted in the ignition of roof structural members. An improperly installed fire detection system failing to give a timely alarm compounded the situation. A major fire loss followed.
- During maintenance in a sanitary lift pump engine, gasoline was spilled on the floor. An open flame heater nearby ignited the explosive vapors that quickly developed. Suffering extensive burns, the civil engineering mechanic died within 48 hours.
- In still another incident, an occupant of military family housing used gasoline to clean automobile parts in his kitchen sink. The gasoline vapors were quickly ignited by the pilot light of the nearby gas range.
- A discarded lighted cigarette was blamed as the cause of a recent commissary fire. The facility was damaged extensively. Employees who habitually smoked in the warehouse discarded cigarette butts on

the floor. At the end of the work day, the floor sweepings were intermingled with empty boxes and paper wrappings accumulated from restocking the sales counters. After the facility was closed to the public, warehousemen continued to work. A short time later, fire broke out and quickly involved the entire facility. Twenty employees narrowly avoided death by forcing their way through a locked door.

In Fiscal Year 1974, reported Air Force fire losses were approximately $4 million, largely due to the types of fire described in the foregoing examples. It is interesting to note that in Fiscal Year 1973, reported monetary fire losses were slightly more than $1 million, an all-time Air Force low.

Needless fires continue to occur. The results are always the same: loss of life, mission interruption, extensive monetary loss and in several instances, a monetary loss for those involved. Why does the Air Force continue to experience these tragic events?

Fire prevention is not an easy task. The press of other work and the unfamiliarity of fire behavior leads to complacency and unsafe practices by base personnel and their dependents which breed potential fires. Fire loss records reflect unsafe acts, improper work procedures, carelessness and just plain ignorance as the cause of our most disastrous fires. Failure of commanders, work area supervisors and sponsors of military family housing to provide effective supervision and to enforce established fire and safety criteria continue to be the prime contributing factors to these fires.

The Base Civil Engineer (BCE) bears the responsibility for providing adequate protection for facilities on his installation. The responsibility involves insuring safe construction through engineering, the selection of proper building materials, providing installed protection, adequate utilities and maintenance of a fire department. The BCE must also keep facility occupants informed of fire prevention practices and procedures encumbent upon them. This latter service is provided by the technical service functions of a base fire department.

A cursory review of Air Force fire statistics reveals that many of the fires reported were caused by improper work procedures or omissions on the part of the workman. A parallel number was caused by facility occupants ignoring common sense rules.

The Base Civil Engineering function as a whole must take the lead in making every Air Force member and employee aware of the dangers of fire, its causes and the effect of the everyday working and living activities. There are various methods available for providing information to Air Force personnel.

The BCE fire inspectors provide direct and personal contact with base personnel. The fire department offers fire prevention training and demonstrations to all base organizations. Speakers may be provided at schools, wives club meetings, commanders call and similar gatherings. These opportunities as well as base newspapers and daily bulletins are available tools. Use them.

In house, the BCE can insure that during project reviews, sound fire protection features are included at each level of design. During these reviews, close coordination between project engineer and fire department personnel is a must to insure that adequate fire protection such as sprinkler systems, alarms and detector systems are included and that materials to be used meet fire protection standards. During the construction phase, sites should be visited by fire inspectors accompanied by foremen to insure that all fire preventive practices are in effect. The key is good coordination of all civil engineering functions.

Without exception, the major fires experienced during Fiscal Year 1974 could have been prevented. HQ US Air Force agrees that everybody must be involved in order to have an effective fire prevention program, but the lead role must be played by the BCE and his people. Each installation must insure that it has the best fire prevention program possible. Remember, fire prevention is an essential part of the Air Force mission.

Ask yourself these questions: (1) Can we afford a major fire? (2) Can we waste dollars urgently needed elsewhere? (3) Can we needlessly jeodpardize any part of the Air Force mission? (4) Can we endanger the lives of our people and find words of comfort after a tragic fire? Of course, the answer is **no.**

Fire prevention is everybody's job. The BCE must lead the way in providing fire safety and in securing the cooperation of base personnel. It is a difficult but not impossible task. A concerted effort can make us free from the dangers of fire. **CE**

COLONEL VITALE *is Chief of the Fire Protection Office, Directorate of Civil Engineering, Headquarters US Air Force. He received his bachelor's degree from Virginia Military Institute and his master's degree from the University of Michigan. He is a graduate of the Army Command and General Staff College.*

Here is a concise collection of some of the major avenues that are available to the Base Civil Engineer in getting new or improved facilities . . .

THE ROAD TO RICHES

by Bernard C. Meredith, PE, and Robert E. Jamison, PE

Although a Base Civil Engineer's (BCE's) first and major concern is to keep his existing plant functioning and in a good state of repair, there is no denying that his performance is most often measured by:

- How well he responds to new or changing building requirements; and
- His ability to provide the construction his commander deems necessary.

Toward this end, the BCE has several program avenues available. These can be the roads to riches if fully understood and properly used, and what follows is an anthology of the major avenues that are available.

Military Construction Program (MCP)

The avenue that comes first to mind is the annual MCP. Project documentation for the MCP is developed and submitted by the bases to the major commands for review, usually in May. The commands in turn forward projects surviving their reviews to Headquarters US Air Force in early July. Here the Facilities Requirements Committee (FRC), which is comparable in function to base and command Facilities Boards, again reviews each project. Action by the FRC culminates in October with submittal of the budget to the Office, Secretary of Defense (OSD). The program is then reviewed by OSD and sent to Congress shortly after New Year's Day.

Breakage at OSD and Congress is usually nominal, therefore the main hurdle in gaining approval for new construction rests with the FRC. As at base and major command, the opinion of the using function/staff agency's representative pretty well decides the project's fate. It is, therefore, important that the user at base keep in close contact with his counterpart at command, who in turn must maintain close liaison with his FRC counterpart.

The cost of individual projects included in the MCP is formally constrained only by the Total Obligation Authority (TOA) allocated to the Air Force. This averages about $300 million a year. Other factors that typically bear on the success of any project are equitable distribution of the TOA among commands, amount of MCP per year at any given base, accent on certain programs/classes of facilities in any year, political considerations, and impacts of force and weapon systems changes/deployments.

Before any MCP project can be constructed, both an Authorization and an accompanying Appropriation, by line item, must be obtained from the Congress. Authorization is obtained through review by the Armed Services Committees of both Houses while Appropriations are gained through concurrent review by the Appropriations Committees of both Houses. This occurs anywhere from a year to a year-and-a-half after submission by the base.

While a project must travel through a considerable period of time and must survive review at all levels of command by several agencies, its chances of success lie mainly with the using agencies and their willingness to support it at all levels of command. This is true, not only for the MCP, but for the other programs which are discussed in the paragraphs that follow.

Natural Disaster Military Construction

Permanent or standing authorization is available (10 USC 2673) for replacement of facilities destroyed by natural disaster such as floods, storms and fires. While there is no limitation on project cost, this authorization is never funded in advance; projects approved under this authority are funded either through savings on/or deferrals of regular MCP projects and, unlike MCP, do not require Congressional line item authorization. Projects are submitted as need (disaster) occurs. Processing differs from the regular MCP in that each project is handled singly as it is received and the source of funds is identified to OSD and the Congress from previously approved line items (along with reasons why these authorized line items can be cancelled).

In recent practice Natural Disaster Construction requirements that individually cost less than $300,000 have been processed as urgent minor construction (P-341) projects. Early issuance of an OSD directive, dictating this practice, is expected.

Emergency Military Construction

The Annual MCP contains blanket provision for items involving (1) unforseen security considerations, (2) new weapons developments, (3) new and unforseen research and development requirements, and (4) improved production schedules requiring facilities. For a facility project to qualify, OSD must determine that deferral to the next MCP is not in the interest of national security.

The method of processing, funding and authorization is the same as for the natural disaster program described previously. The Air Force is, however, limited by the annual MCP legislation to a specified dollar ceiling. Over the past several years, this has been $10 million per year.

Secretary of Defense Military Construction Authority

This program is somewhat similar to the two programs just discussed. Each year OSD is authorized and furnished an equivalent appropriation in this account. This program is used for urgent facility requirements that in hostile situations are deemed vital to the security of the United States. It may also be used for facilities in non-hostile situations if they meet the additional criteria of being unable to await inclusion in a subsequent annual Military Construction Authorization.

Projects for overseas areas must be submitted through the appropriate Unified or Specified Command to the Joint Chiefs of Staffs. When not in an overseas area, the project is submitted through regular Air Force channels. Requests for use of this authority must clearly enunciate the factors that make it vital to the security of the United States. In addition, they must provide reasons why the project cannot await inclusion in the next MCP, and they must include a schedule for accomplishment.

Urgent Minor Construction, P-341

Projects accomplished under this portion of the MCP (annually appropriated at about $15 to $20 million) must meet the test of urgency. Urgency is defined as an unforseen requirement that cannot await inclusion in subsequent MCP.

Projects are limited individually to a cost between $50,000 and $300,000. The Secretary of the Air Force (SAF) is authorized to approve those individually costing less $100,000 while those costing up to $300,000 require OSD approval. As mentioned earlier, this authority has been used in recent practice for Natural Disaster and Emergency MCP items costing under $300,000.

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Fast Amortizing P-341

Approximately a year ago, the United States Code was revised to permit use of the P-341 authority, without certification of urgency, for projects which will amortize the cost of construction within a three year period. The discounting economic analysis techniques in **AFR 172-2** are used in determining if the three year criteria can be met.

Minor Construction Under $50,000

Minor construction projects within the authority of the major command are individually limited to a funded cost of $50,000. These projects do not need to meet the urgency criteria required for P-341 projects. Funding is gained from Operations and Maintenance, Research-Development-Testing and Evaluation, or Industrial Funds available to the command.

Repair By Replacement

This is an excellent approach to modernizing parts

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ROAD TO RICHES
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of existing facilities, especially utility systems. SAF approval is required when the project costs exceed 50 percent of the replacement cost for the entire facility/system. Where the 50 percent threshold is not crossed, individual project authority up to $200,000 rests with the major command, projects costing in the range from $200,000 to $300,000 require approval by the Air Force Director of Civil Engineering (AF/PRE); and above $300,000, the SAF retains approval authority. In International Balance of Payment areas, the major command's authority is limited to $50,000 while projects exceeding that cost require SAF approval. Funding avenues mentioned for Minor Construction under $50,000 apply here as well.

Moveable Equipment

AFR 170-14 explains which items of equipment are considered as construction, Real Property Installed Equipment (RPIE), and which qualify as non-construction, non-RPIE. In recent years, several specific rulings have been issued which designate certain items of equipment previously considered as RPIE, to be non-construction items of moveable equipment. Among these are aircraft arresting barriers, raised flooring for computer installation, air conditioning when not for human comfort, and no-break power.

Both the procurement and the cost of installation of moveable equipment is considered non-construction. Whether O&M or Procurement funds are used for installation is determined by the criteria in **AFR 170-14.** Where a local decision cannot be made on whether an item qualifies as moveable equipment, the next level of command should be contacted for assistance.

Nonappropriated Funds

This is by far the most complex and confusing program available; however, it is worth the effort to master the intricacies of project processing since the program accounts for more than $50 million in new and modernized facilities each year. This is the program that provides youth centers, recreation facilities, theaters, commissary improvements and the like. Space does not permit an explanation of all aspects/limitations/approval authorities; however, the more cogent ones will be enumerated.

Basically, projects costing in excess of $50,000 require AF/PRE project approval while those in excess of $300,000 require SAF approval and reporting to Congress prior to award of construction contracts.

Projects funded with Welfare, Sundry or Book Funds require funding approval of the Air Force Welfare Board if they exceed $200,000. Additionally, the Welfare Board can be approached for loans of funds, and in the past several years, the Board has authorized an Annual Special Welfare Grant program. Under this program, the Board has granted funds, additional to regular distribution, for special projects at wide cost ranges. Unfortunately, the fund situation has not permitted a Special Welfare Grant this year.

The Army and Air Force Civilian Welfare Fund is operated similarly to its military counterpart but on a much smaller scale. Air Force Logistics Command, with its large employment of civilians, has been able to finance such projects as a golf course, health club, civilian club and the like.

The Army and Air Force Exchange Service (AAFES) and The Army and Air Force Motion Picture Service (AAFMPS) provide funds for new and improved exchange theater facilities. AAFES and AAFMPS have project approval up to $300,000. The local Service managers usually are the driving force for facilities upgrading projects while most new/replacement facilities projects are generated by the Service Headquarters.

The Commissary Trust Revolving Fund Committee at Headquarters US Air Force dispenses residual surcharge funds for construction and associated equipment for commissary projects. In general, projects are limited to upgrading, addition or conversion of other facilities class space. Priority is afforded to "minor construction" projects costing not more than $300,000. This limitation is not applied to the associated equipment which, as a rule, runs about two-thirds the cost of construction.

Banks and Credit Unions are among the private associations that may elect to finance facility construction on the base. If so, title is vested in the Air Force, but the Bank or Credit Union is granted a lease (usually limited to 15 years) for that space. The lease must be approved by AF/PRE. Upon expiration of the lease period, the Air Force may elect to renew the lease with the original or an alternate association.

Even with all of these avenues available, it is still no meanial task to obtain approval for that new facility because, after all, your project must compete with an existing $7 billion facilities deficiency in the Air Force. Still, the BCE, who is well informed about programs that are available and how to use these resources, definitely has one leg up. Each of these programs has its place and application; however, there is enough similarity from one to another that it may sometimes be a matter of choice. With today's large deficiency in Air Force facilities, the BCE may find that some of these programs are oversubscribed and not responsive to his needs. In such a case, another program may be the way to solve the base problem. The BCE who knows all available alternatives is in the best possible position to serve his commander. If he can get each user to establish dialogue with his counterpart at the next level of command for corroboration and support, he is well on the way. CE

Editor's Note: The following is a condensation of a joint research project performed by the authors as part of the new Master of Facilities Management Program at the School of Systems and Logistics, Air Force Institute of Technology.

A structure for planning and controlling the efforts of personnel within an organization and at the same time providing a means of expressing the broad goals of the organization and integrating the goals of the different organizational levels can be called . . .

Civil Engineering

A Hierarchy of Objectives

by Capt Palmer G. Arnold, Capt Richard E. Ducharme and Capt David F. Fink

Since the creation of the Department of the Air Force, the Base Civil Engineering function has grown into a management task which involves many areas of responsibility. The Base Civil Engineer (BCE) is responsible for achieving high visibility into all of these potential and existing problem areas. Yet, Inspector General reports still point out basic problems which are undetected by BCEs. In some cases, a problem may not be caused by neglect of the BCE, but could be a result of insufficient time for him to pinpoint the undetected problem areas in addition to handling his high priority duties and responsibilities. In other cases, in order to carry out his responsibilities and duties, the BCE has had to resort to a "crisis management" approach. The Directorate of Civil Engineering at Headquarters US Air Force has recognized this trend and has directed that: "**The trend in civil engineering must change from 'crisis management' to management by objectives in conjunction with proven management by exception principles.**"

Existing information systems provide a basis for management by objectives and sufficient information to make decisions with respect to those objectives. However, many officers believe that the BCE has a need for an additional management tool. An example would be a simplified chart or model which would give the BCE a quick overview of his organization's direction, a problem detection system which would highlight those areas which deserve his attention, and let him know which areas are within his expectations. If such an aid existed, he could identify those areas now overlooked, and could use existing systems to obtain information needed to make corrective decisions. It would seem that such an aid should be based on the fundamental objectives of the civil engineering organization.

In each organization there exists a fundamental hierarchy of objectives which may or may not be recognized by management. These objectives can encompass areas which are the results of internal or external stimulation. The hierarchy is started at the top level of management where broad objectives and goals are established; these are the primary objectives which are further broken down into secondary objectives in the different departments. These, then, are further broken down by the branches, work centers and work groups. Thus, a hierarchy is created.

The hierarchy of objectives in an organization provides a structure for planning and controlling the efforts of personnel within the organization. It also provides a means of expressing the broad goals of the organization and integrating the goals of the different organizational levels, which help achieve the overall goals. Additionally, by identifying valid performance indicators for each objective, the basis for an effective management problem detection system could evolve.

The essence of the problem is twofold:

- First, determine what the fundamental base civil engineering organization objectives are, and then,
- Second, determine what related performance indicators could aid in measuring progress toward these objectives.

There were four goals of the research effort by the authors of this article: First and most important, to identify the organizational objectives which the BCE must achieve to insure accomplishment of the mission of the civil engineering organization. Second, to identify performance indicators which could be used to monitor the progress of the civil engineering organization toward these objectives. Third, to determine how often the performance indicators need to be reviewed to insure timely correction of "out of control" conditions. Fourth, to arrange the civil engineering organizational objectives and performance indicators into a hierarchical model which the BCE could use as an aid in detecting problem areas in his complex organization.

The main emphasis in the study was focused on only the primary and secondary objectives which are fundamentally important to the BCE rather than on all levels of objectives. This was in consonance with the goal to develop an aid which would provide an overall view, or a way to separate the forest from the trees.

Further, it was neither the goal nor within the scope of the study, to establish reportable quantita-

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Objectives *cont'd*

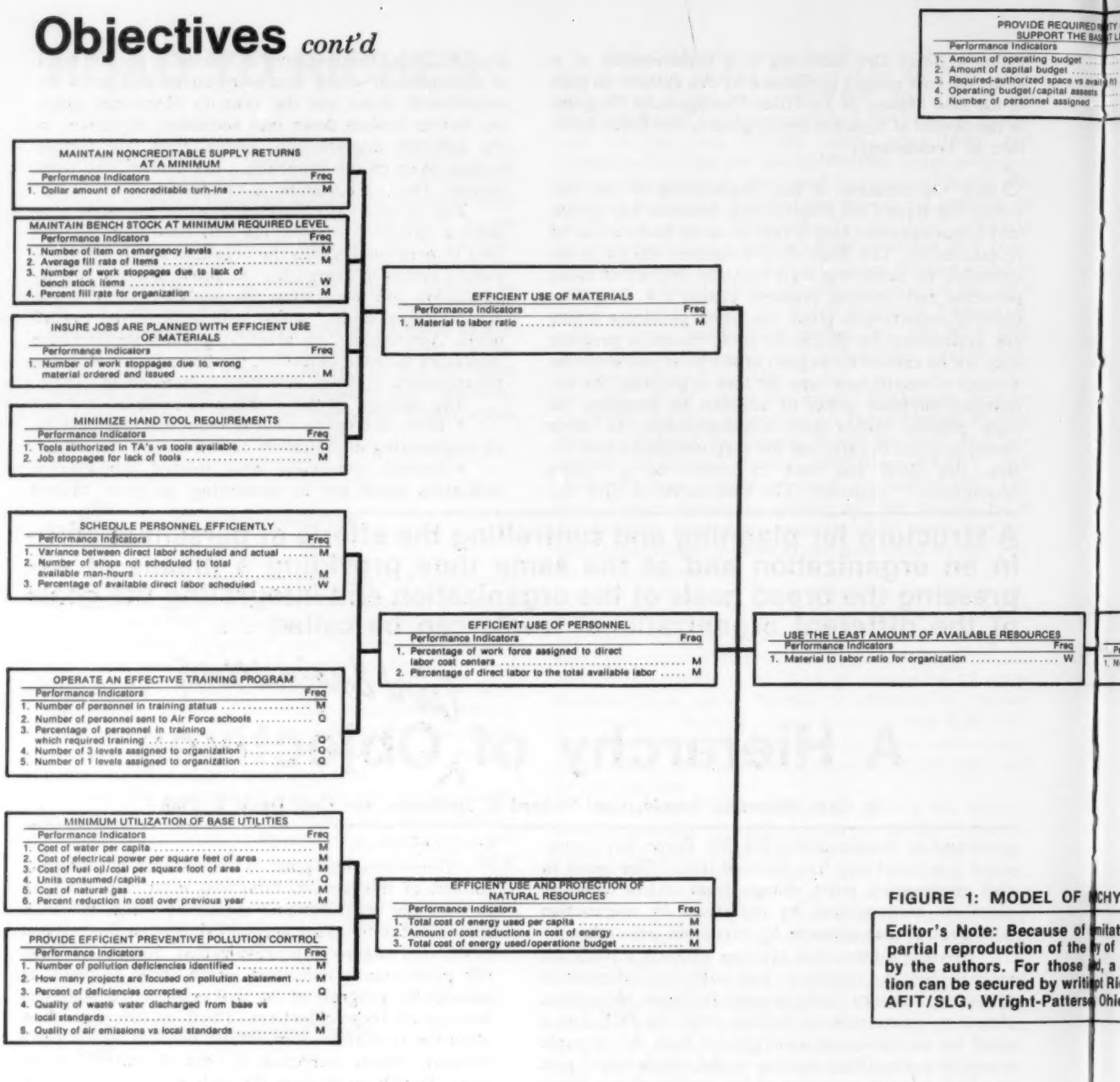

PROVIDE REQUIRED ... SUPPORT THE BA...
Performance Indicators
1. Amount of operating budget
2. Amount of capital budget
3. Required-authorized space vs avail...ft)
4. Operating budget/capital assets
5. Number of personnel assigned
MAINTAIN NONCREDITABLE SUPPLY RETURNS AT A MINIMUM
Performance Indicators Freq
1. Dollar amount of noncreditable turn-ins M
MAINTAIN BENCH STOCK AT MINIMUM REQUIRED LEVEL
Performance Indicators Freq
1. Number of item on emergency levels M
2. Average fill rate of items M
3. Number of work stoppages due to lack of bench stock items W
4. Percent fill rate for organization M
INSURE JOBS ARE PLANNED WITH EFFICIENT USE OF MATERIALS
Performance Indicators Freq
1. Number of work stoppages due to wrong material ordered and issued M
MINIMIZE HAND TOOL REQUIREMENTS
Performance Indicators Freq
1. Tools authorized in TA's vs tools available Q
2. Job stoppages for lack of tools M
EFFICIENT USE OF MATERIALS
Performance Indicators Freq
1. Material to labor ratio M
SCHEDULE PERSONNEL EFFICIENTLY
Performance Indicators Freq
1. Variance between direct labor scheduled and actual M
2. Number of shops not scheduled to total available man-hours M
3. Percentage of available direct labor scheduled W
OPERATE AN EFFECTIVE TRAINING PROGRAM
Performance Indicators Freq
1. Number of personnel in training status M
2. Number of personnel sent to Air Force schools Q
3. Percentage of personnel in training which required training Q
4. Number of 3 levels assigned to organization Q
5. Number of 7 levels assigned to organization Q
EFFICIENT USE OF PERSONNEL
Performance Indicators Freq
1. Percentage of work force assigned to direct labor cost centers M
2. Percentage of direct labor to the total available labor M
USE THE LEAST AMOUNT OF AVAILABLE RESOURCES
Performance Indicators Freq
1. Material to labor ratio for organization W
MINIMUM UTILIZATION OF BASE UTILITIES
Performance Indicators Freq
1. Cost of water per capita M
2. Cost of electrical power per square feet of area M
3. Cost of fuel oil/coal per square foot of area M
4. Units consumed/capita Q
5. Cost of natural gas M
6. Percent reduction in cost over previous year M
PROVIDE EFFICIENT PREVENTIVE POLLUTION CONTROL
Performance Indicators Freq
1. Number of pollution deficiencies identified M
2. How many projects are focused on pollution abatement M
3. Percent of deficiencies corrected Q
4. Quality of waste water discharged from base vs local standards M
5. Quality of air emissions vs local standards M
EFFICIENT USE AND PROTECTION OF NATURAL RESOURCES
Performance Indicators Freq
1. Total cost of energy used per capita M
2. Amount of cost reductions in cost of energy M
3. Total cost of energy used/operations budget M

FIGURE 1: MODEL OF ...CHY

Editor's Note: Because of ...imitat... partial reproduction of the ...y of ... by the authors. For those ...ed, a ... tion can be secured by writing ...t Ri... AFIT/SLG, Wright-Patterso... Ohi...

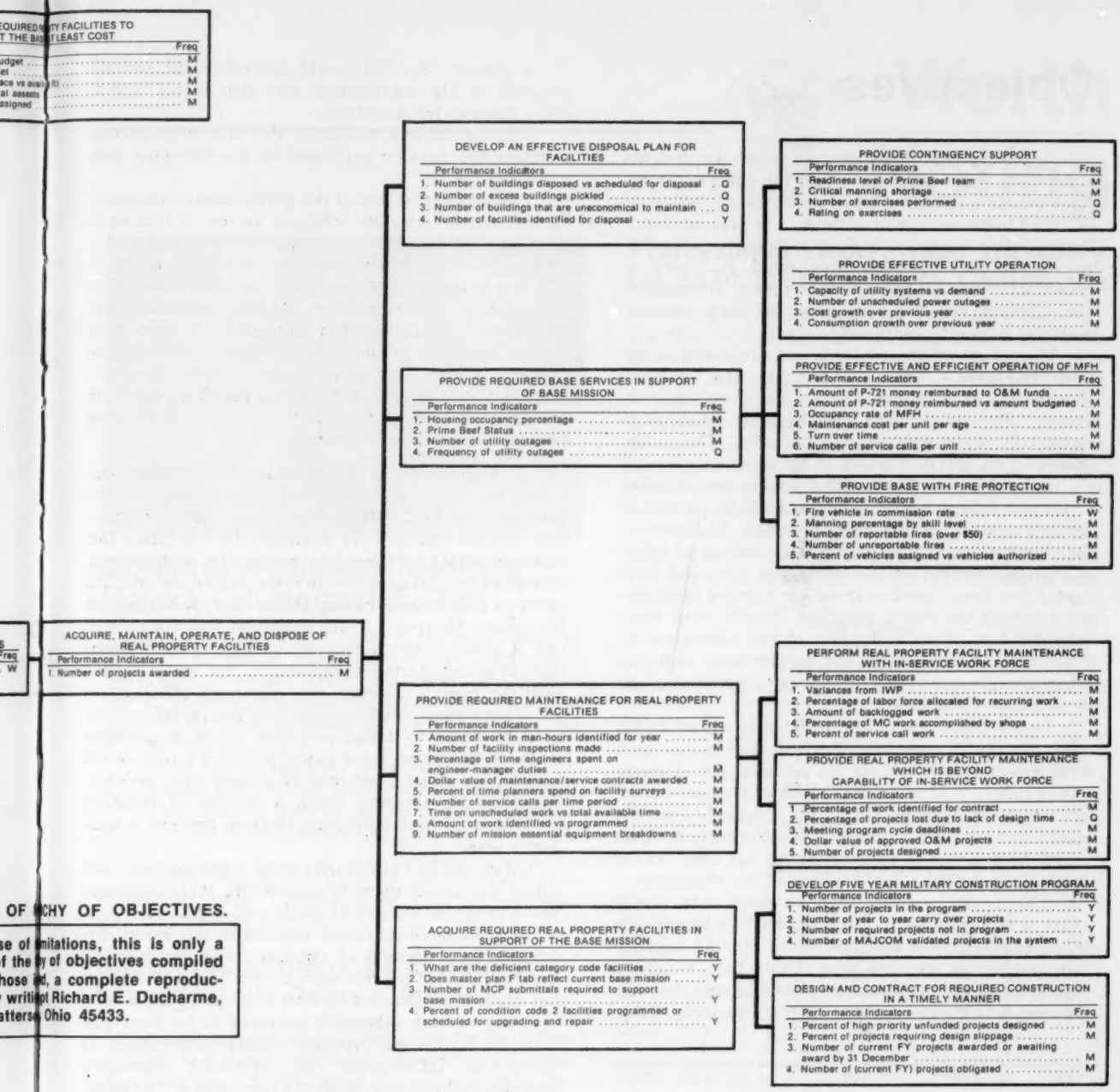
tive performance **standards.** It seems that the setting of numerical standards for a management aid designed solely to help the BCE should be the responsibility of the BCE, since he can base these standards on local conditions and, more significantly, on his individual needs.

The research plan used for addressing the goals of the study was subdivided into **four dependent** phases.

The **Initial Phase** was an extensive review of facilities management and general management literature to tentatively identify objectives that would relate to an Air Force base civil engineering organization. The information that was obtained was used to establish a tentative hierarchical model of base level civil engineering objectives.

The **Second Phase** consisted of a series of personal interviews with senior officers in Air Force Civil Engineering who had extensive civil engineering experience. In addition, these officers provided additional expertise for developing and refining the model.

These interviews provided an interface between the theories presented in maintenance management literature and the opinions of functional experts; however, information obtained from the literature indicated that opinions from operating managers should also


ACQUIRE, MAINTAIN, OPERATE, AND DISPOSE OF REAL PROPERTY FACILITIES
Performance Indicators Freq
1. Number of projects awarded M
DEVELOP AN EFFECTIVE DISPOSAL PLAN FOR FACILITIES
Performance Indicators Freq
1. Number of buildings disposed vs scheduled for disposal Q
2. Number of excess buildings pickled Q
3. Number of buildings that are uneconomical to maintain Q
4. Number of facilities identified for disposal Y
PROVIDE REQUIRED BASE SERVICES IN SUPPORT OF BASE MISSION
Performance Indicators Freq
1. Housing occupancy percentage M
2. Prime Beef Status M
3. Number of utility outages M
4. Frequency of utility outages Q
PROVIDE REQUIRED MAINTENANCE FOR REAL PROPERTY FACILITIES
Performance Indicators Freq
1. Amount of work in man-hours identified for year M
2. Number of facility inspections made M
3. Percentage of time engineers spent on engineer-manager duties M
4. Dollar value of maintenance/service contracts awarded M
5. Percent of time planners spend on facility surveys M
6. Number of service calls per time period M
7. Time on unscheduled work vs total available time M
8. Amount of work identified vs programmed M
9. Number of mission essential equipment breakdowns M
ACQUIRE REQUIRED REAL PROPERTY FACILITIES IN SUPPORT OF THE BASE MISSION
Performance Indicators Freq
1. What are the deficient category code facilities Y
2. Does master plan F tab reflect current base mission Y
3. Number of MCP submittals required to support base mission Y
4. Percent of condition code 2 facilities programmed or scheduled for upgrading and repair Y
PROVIDE CONTINGENCY SUPPORT
Performance Indicators Freq
1. Readiness level of Prime Beef team M
2. Critical manning shortage M
3. Number of exercises performed Q
4. Rating on exercises Q
PROVIDE EFFECTIVE UTILITY OPERATION
Performance Indicators Freq
1. Capacity of utility systems vs demand M
2. Number of unscheduled power outages M
3. Cost growth over previous year M
4. Consumption growth over previous year M
PROVIDE EFFECTIVE AND EFFICIENT OPERATION OF MFH
Performance Indicators Freq
1. Amount of P-721 money reimbursed to O&M funds M
2. Amount of P-721 money reimbursed vs amount budgeted M
3. Occupancy rate of MFH M
4. Maintenance cost per unit per age M
5. Turn over time M
6. Number of service calls per unit M
PROVIDE BASE WITH FIRE PROTECTION
Performance Indicators Freq
1. Fire vehicle in commission rate W
2. Manning percentage by skill level M
3. Number of reportable fires (over $50) M
4. Number of unreportable fires M
5. Percent of vehicles assigned vs vehicles authorized M
PERFORM REAL PROPERTY FACILITY MAINTENANCE WITH IN-SERVICE WORK FORCE
Performance Indicators Freq
1. Variances from IWP M
2. Percentage of labor force allocated for recurring work M
3. Amount of backlogged work M
4. Percentage of MC work accomplished by shops M
5. Percent of service call work M
PROVIDE REAL PROPERTY FACILITY MAINTENANCE WHICH IS BEYOND CAPABILITY OF IN-SERVICE WORK FORCE
Performance Indicators Freq
1. Percentage of work identified for contract M
2. Percentage of projects lost due to lack of design time Q
3. Meeting program cycle deadlines M
4. Dollar value of approved O&M projects M
5. Number of projects designed M
DEVELOP FIVE YEAR MILITARY CONSTRUCTION PROGRAM
Performance Indicators Freq
1. Number of projects in the program Y
2. Number of year to year carry over projects Y
3. Number of required projects not in program Y
4. Number of MAJCOM validated projects in the system Y
DESIGN AND CONTRACT FOR REQUIRED CONSTRUCTION IN A TIMELY MANNER
Performance Indicators Freq
1. Percent of high priority unfunded projects designed M
2. Percent of projects requiring design slippage M
3. Number of current FY projects awarded or awaiting award by 31 December M
4. Number of (current FY) projects obligated M

OF ...CHY OF OBJECTIVES.

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be solicited when establishing objectives. Most management authorities believe that operating managers should participate in the formulation of an organization's hierarchy of objectives. Organizational objectives formed in this manner often receive greater support from all management levels.

Thus, the **Third Phase** was a solicitation of opinion from a sample of operational managers on the proposed objectives and performance indicators in the hierarchical model. This phase required the design and distribution of two research instruments used in the study. The first instrument contained a tentative hierarchy of objectives, the second related to possible performance indicators.

The operating managers chosen for the first survey were asked to review the model and made applicable comments, corrections or criticisms that they deemed necessary. Their responses were related to the acceptance, phrasing and position of the objectives in the tentative hierarchy. The information received from the operating managers with respect to objectives was used to finalize the hierarchical model and provided the basis for the final phase of the research plan.

The **Final Phase** of the research plan was the dis-

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Objectives *cont'd*

tribution of a second questionnaire to the respondents of the first. This instrument asked the operating managers to rate a tentative list of performance indicators as "need to know," "nice to know," or "not needed." They were also asked to indicate a desired review frequency for the indicators they rated as "need to know" or "nice to know." The review frequencies were divided into the categories of: daily, weekly, monthly, quarterly and yearly.

The results of the research are presented in the model in **Figure 1.** The model indicates that the overall objective of base level civil engineering organization is: "Provide required Real Property Facilities to support the base mission at least cost." Thirty-nine subobjectives are also shown in the hierarchical model. Each block in the model contains an objective which was judged important by at least 85 percent of the civil engineering managers sampled. Additionally, each block depicts those performance indicators which at least 60 percent of the managers surveyed have agreed that they "need to know" to monitor their progress toward the stated objective. Finally, each block indicates how often a plurality of the managers believes they should receive the performance indicator information in order to insure timely correction of out of tolerance conditions.

The intended use of the model is as an aid to the individual BCE; therefore, the first step is that each BCE must tailor the aid for his personal use. This requires that he add or delete any objectives or indicators which he believes should be changed. Then he must establish numerical standards for each indicator which he believes is appropriate for his base, and if met will lead to the achievement of his objectives.

The hierarchy could then be made into a wall chart or reporting form, to be updated as appropriate by an administrative assistant using existing information systems as the data base. Using the "exception principle," a red pin would be placed in **only those indicators** which exceeded the BCE's standards. Thus, "in a glance" the BCE could determine the overall progress of his organization and also detect which areas deserve his attention.

The use of this model by the civil engineering manager can best be explained by the following two examples.

1. Assume that one of the performance indicators for the overall objective indicates an out of tolerance condition. This would be the basis for a signal to the civil engineer manager that some corrective action is required to assure continued progress toward the overall objective. The manager would then proceed down the hierarchy to the level of objectives which isolates the source of the problem. For example, if the deviation affects the "Operating Budget/Capital Assets," he would further narrow down the possible source of the deviation through the model until the specific area causing the problem is found.

2. Assume that a deviation from a standard occurred at a lower level objective. The manager again would receive notification of an out of tolerance situation, by the red pin, for example. In this case, the manager would only need to review the performance indicators for that objective in order to find the specific problem area without having to consider the balance of the model. However, if this condition was not corrected, it would eventually cause its higher level objectives to go out of control, and the process would repeat until the overall objective was adversely affected.

These examples illustrate how the model can be used by BCEs to detect and take action in problem areas. In this respect, the model provides a framework for decision-making and may be compared to an electronic trouble shooting chart, a method of isolating problem areas and correcting them to prevent a total power loss.

Many BCEs believe they need a management aid which will assist them in monitoring their organization's progress toward its goals and objectives.

The hierarchical model derived in this study, developed by a sample of operating civil engineering managers, could provide such an aid. The objectives in this model are reflective of what a sample of base level civil engineering managers perceive to be their primary goals. The performance indicators are those 92 pieces of information the operating managers surveyed believe they need, "by exception," to monitor the overall progress of their organization.

The authors of this article believe that BCEs, with the aid of such a model, could quickly detect those areas which are not meeting "their" standards and could channel their efforts toward those areas. However, it was not the intent of this study to provide the "only model" that can be used. It is one which can be used as a foundation for thought. Individual BCEs could use it as a starting point, eliminating or adding to tailor the tool to their particular needs. BCEs can set the standards they feel are appropriate, and then use the resulting model as their personalized management aid which would quickly highlight the "red pin" areas which need their attention. CE

Here's How to Get on Journal Distribution List

If your civil engineering organization does not receive the **Air Force Civil Engineer** (AFRP 85-1) journal, or receives fewer than a ratio of one copy for every 10 readers, you should make your requirements known to your servicing Publications Distribution Office (PDO). Fill out AF Form 764A as shown in **AFM 7-1** and send it to the PDO. If the request is valid, the PDO will forward it to the Publications Distribution Center in Washington, DC, which distributes AFRP 85-1 to Air Force installations worldwide.

Worth Noting

School of Aerospace Medicine Honors Col Herbert E. Bell

In a surprise announcement at the culmination of the 10th Bi-Annual Bio-Environmental Engineering Symposium at Brooks AFB, Texas recently, Col Herbert E. Bell was presented the Bio-Environmental Engineer of the Year Award by the US Air Force School of Aerospace Medicine.

The special recognition, accorded for only the fifth time in eight years by the School, honors an individual for his high state of professionalism and for his contribution to the bio-environmental sciences in the Air Force.

Colonel Bell is the Chief of the Environmental Protection Group, Directorate of Civil Engineering, Headquarters US Air Force.

Base Procurement/BCE Related Management Course Available

Seeking a better understanding of the Base Procurement and Base Civil Engineering interface? If so, you should apply for The Base Procurement/BCE Related Management Course 165. For BCE and Procurement personnel, this course offers an understanding of those problem areas in which base contracts are accomplished.

The Base Procurement/BCE Related Management Course 165 is listed in the Defense Management Education and Training Catalog DOD 5010.16C. Request your Base Education and Training Office to submit a DD Form 1556, Enrollment and Registration Request, through your major command to: Registrar, AFIT/SLC-1, Wright-Patterson AFB, Ohio 45433. If you have any questions concerning the course, contact Maj Bert Johnson at the Civil Engineering School, Autovon 78, extension 55913 or 55904.

Professional Registration Directory for 1974 Distributed to Commands

The 1974 edition of the Air Force Civil Engineering **Directory of Professional Registration** has been distributed to major commands for further distribution to lower echelons.

The Directory lists the names of those professional engineers and architects who are currently licensed. No more than two licenses can be listed. Errors and omissions should be reported to AFIT/DEE, Wright-Patterson AFB, Ohio 45433. Please use the form found in the Directory for reporting purposes.

The summary of registration for 1974 on the back page of the recently distributed Directory is in error. The following figures are correct and should be substituted:

GRADE	PE	RA	RLA	TOTAL PROFESSIONALLY REGISTERED	EIT	AIT	TOTAL IN TRAINING
OFFICERS							
Col	40	1	0	41	2	0	2
LTC	75	2	1	78	9	0	9
Maj	121	9	0	130	31	0	31
Capt	65	2	2	69	140	1	141
1Lt	0	0	0	0	57	0	57
2Lt	0	0	0	0	41	1	42
TOTAL	301	14	3	318	280	2	282
CIVILIAN EMPLOYEES							
GS-17	1	0	0	1	0	0	0
GS-16	1	0	0	1	0	0	0
GS-15	19	2	0	21	0	0	0
GS-14	97	6	5	108	0	0	0
GS-13	320	14	2	336	4	0	4
GS-12	283	29	3	315	13	0	13
GS-11	195	17	0	212	29	0	29
GS-9	1	1	0	2	5	0	5
GS-7	2	0	0	2	0	0	0
TOTAL	919	69	10	998	51	0	51

COCESS Network Diagrams Offered to Base Civil Engineers

A detailed network diagram which will help the Base Civil Engineer in planning and organizing his efforts to establish a COCESS at his base is available from the **Air Force Civil Engineer** journal. Address your request to the Journal, AFIT/DEJ, Wright-Patterson AFB, Ohio 45433.

An article on COCESS (Contractor Operated Civil Engineering Supply Store) was published in the May 1974 issue of the Journal. It discusses the means to develop a successful requirements contract.

Within Pacific Air Forces Command, 9,147 successful arresting barrier engagements were made from 9,236 attempts. This represents a success rate of 99 percent. However, the Air Force cannot be satisfied with less than 100 percent arrestment success. Here's the Command's report on how it strives for that goal.

When Feathers Are Ruffled, Drop Your Hook!

by Col Morris B. Rubenstein, PE

Catching a bird without harming the critter has always been a difficult and delicate task. In Spain, skilled horsemen riding trained horses dart about in orchards after partridge and catch them unharmed in a small butterfly type net. In some mountainous countries, man catches bird by driving him up valleys until at the top he unsuspectingly flies into an outstretched net. The Japanese slip up on placid ducks and catch them by tossing a hoop net over them.

Since 1953, the Air Force has been faced with the bird catching problem, that is, how to catch him unharmed and what device could be used to make the catch. In the Air Force's case, the bird is an airplane, usually a fighter, and the device for the "net" is one of a variety of the Barrier Arresting Kits (BAK) systems. The most popular is the BAK-12, **Figure 1.** It is designed, built and installed for the sole purpose of arresting tail hook equipped aircraft unharmed, traveling up to speeds of 190K and weighing up to 58,000 pounds. As the engagement speed is decreased, the aircraft weight can be increased. By far, the greatest percentage of arrestments concern the F-4 series aircraft. However, any one of the following birds may find itself stopped by a BAK: F-100, F-102, F-104, F-105, F-111 or A-7. In order to safely catch the F-111, the standard BAK-12 system must be modified to provide a longer tape runout. This is done by installing a larger tape drum and longer tape to provide 1500 feet of payout in lieu of the standard 950 feet. Each safe catch is called a successful arrestment.

Over 9,147 successful arrestments were made from 9,236 attempts within Pacific Air Forces (PACAF) Command from 1970 through 1972. This represents a three year success rate of 99 percent. With such a high percentage of successful engagements, it would appear that one would be satisfied that everything possible is being done to catch Air Force birds unharmed; however, such is not the case. The Air Force cannot be satisfied with less than 100 percent arrestment success. The one percent of arrestments that was not successful cost the Air Force untold dollar losses in critically needed weapon systems and crew member injuries and death. One airplane lost, one crew member hurt or killed, cannot be accepted as satisfactory. In this case "almost is not good enough." In the three year time frame within PACAF, 30 aircraft were damaged or destroyed during attempted arrestments. No, "almost 100 percent is not good enough," especially if the failure happens to you or me.

Many good reasons and just as many poor excuses have been given for engagement failures, but one thread seems to wind its way through all the analyses of why Air Force birds miss the net. That single thread tells this: "Net safely catches bird when bird enters net properly," and vice versa. Landing too fast, too near the arrestor cable, and too far off runway center, are the main causes of arresting system catch failures. Of these three, excess speed is the biggest reason for misses.

In order to improve the chances of Air Force pilots for engagement success, PACAF has established a redundancy in arresting systems. The normal configuration for arresting systems on a fighter runway is two each MA-1A, two each BAK-12 and two each BAK-13,

Figure 2 and **Figure 3.** This multiplicity of arrestors has allowed many first time failures to become second time successes. But when a failure does occur, it is most difficult to place the blame. Placement of blame in a gear up landing is not nearly as difficult, but who is at fault when a cable snaps during an engagement? The main reason it is so difficult to pin the fault on the culprit responsible for an unsuccessful engagement is that so many people are involved in the action before, during and after each attempted engagement.

To determine what went wrong, it is necessary to understand what the duties and responsibilities are for each possible contributor to the failure, and what each did before and during the engagement. One of Edsel Murphy's laws delineating the behavior of inanimate objects is, "In any given miscalculation, the fault will never be placed if more than one person is involved." In the case of a miscalculation concerning missing an arrestor, the pilot is the one person who has most to lose and, therefore, should be most concerned. He is also the one person and the only person who can (if his bird's feathers aren't too ruffled) control the too fast, too near the arrestor cable, and too far off runway center. Granted, because of innumerable things that can and do go wrong with airplanes, the pilot, though sitting in the driver's seat, may not be directing all actions that are taking place. He nevertheless is the one and only person who can control whatever is controllable. Therefore, it is to the pilot that arrestors are primarily dedicated. It is hoped that the guidance contained in these paragraphs will aid the pilot in successfully engaging arrestors in the future and help the Air Force to attain the goal of 100 percent engagement success.

There are various arrestors that are designed, constructed, installed and tested to safely catch aircraft with weights and speeds as indicated in **Table 1.** Each system is in use in PACAF today. The systems and their masters, the barrier maintenance and operations crews, are ready, willing and able to safely catch, unharmed, any airplane that makes its approach within the limits established by **Table 1.**

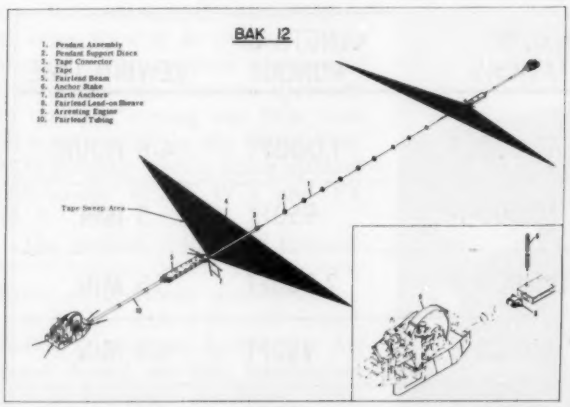

Figure 1: The BAK-12 System.

In fact, a special study conducted for the FY 1971 time frame by the PACAF Inspector General concerning arresting system engagements states that "the operations and maintenance of PACAF arresting barriers by civil engineering personnel, their exploits largely unsung, contributed as much to the excellent PACAF accident prevention program during 1971 as our GCA operators, aircraft maintenance specialists, or any other of the myriad of personnel directly involved in the safe launch and recovery of our aircraft."

An arrestor will do its thing, providing the pilot does his and the bird is cooperative. There is no need to get uptight about taking an arrestor, because landing, even with blown tires, need not be hazardous to one's health. In fact, a good motto to follow is "when in doubt, engage," but do it right. To do it right is no more difficult than making a good landing.

Hints for Successful Engagements

The following hints will greatly improve a pilot's chances for a successful engagement. After he has decided to make an approach engagement, and the tower and all agree, he should relax and prepare for a normal landing. Checking to make sure his shoulder harness is locked, he slows the bird down as much as possible, lowers the tail hook, and makes a normal landing, planning to touch down 500 to 300 feet prior to the cable he has selected. If he decides to take an arrestor during roll out or for an aborted take off, he deploys the drag chute and lowers the tail hook at least 1000 feet in front of the cable. He then concentrates on steering straight down the center of the runway and gets off the brakes well before crossing the cable. Although engagements should always be made as slow as possible, there are two reasons for **not** applying brakes before engagement:

- Braking causes "hook skip." This occurs when the angle between the hook shank and the runway is enough to raise the hook point off the runway. till it rides over the cable instead of picking it up.
- The main reason for not applying brakes near the cable is that in case of a blown tire, during either take-off or landing, it is absolutely essential that the wheel rim roll, not slide, over the cable.

In almost every instance wherein brakes are locked and a main gear rim slides over the cable, the cable is cut, leaving nothing for the hook to pick up. It might seem unreasonable to the pilot that a plane wheel would cut an inch and a quarter steel cable, but think of it as a shear with almost 10 tons downward force slicing forward and across a cable at 200 miles per hour. Considering it in these terms, cutting the cable with the wheel rim suddenly seems as probable as a new razor cutting a wet noodle. Without applying brakes, there is a good possibility of hooking the cable and safely stopping even with a blown tire.

Here is an extract of a recent incident which describes an F-4 with a blown tire making a successful midfield engagement at one of our bases:

"The landing was normal and the chute was de-

cont'd on next page

Drop Your Hook *cont'd*

ployed. At 100 KTS, the anti skid system was checked as required per FCF. The system cycled once but felt stiff. Brake pressure was maintained until the next cycling, but the left main tire blew out before this cycling occurred. Nose gear steering was engaged, anti skid turned off, and hook lowered. The mid-field barrier was engaged without further incident."

A pilot should stay off the brakes, especially if his aircraft is short a tire. Also, he should apply sufficient aft stick to **preclude** a nose low aircraft attitude, which also causes hook skip, and assures full extension of the nose gear strut, but he must keep the nose wheel on the runway. When the hook picks up the cable, he should not touch the brakes and he will ride to a smooth, but rapid stop. The object now is to get unhooked and off the runway without delay. He touches the brakes only lightly and lets the stretch in the tape roll the bird back enough for the hook to free itself from the cable. This usually happens automatically. The barrier crew point man, who will shortly be standing in front of the airplane, will assist in getting unhooked. Since different procedures are used for unhooking from the various arrestor systems and the point man can see where the pilot is hung up, the pilot should do as he directs. He then will be off the runway in a minute so he can prepare to go fly and fight again. If after all this, the pilot somehow misses an engagement, he should not panic or reach for the salt; instead, he should just stay as near the runway center line as possible and he will have a second chance. Nope, salt is not the answer. CE

COLONEL RUBENSTEIN *is the Deputy Chief of Staff, Civil Engineering, Headquarters Aerospace Defense Command, Ent AFB, Colorado. He earned his bachelor of science degree in civil engineering from The Citadel. His experience covers 25 years in Air Force Civil Engineering. He is a registered Professional Engineer in Kansas and a member of the Society of American Military Engineers.*

Table 2: PACAF Barrier/Arrestor Configuration 1.

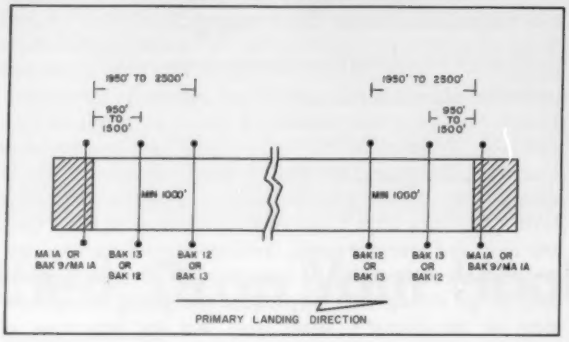
1950' TO 2500'
950' TO 1500'
MIN 1000'
MA IA OR BAK 9/MA IA
BAK 13 OR BAK 12
BAK 12 OR BAK 13
BAK 12 OR BAK 13
BAK 13 OR BAK 12
MA IA OR BAK 9/MA IA
PRIMARY LANDING DIRECTION

Table 3: PACAF Barrier/Arrestor Configuration 2.

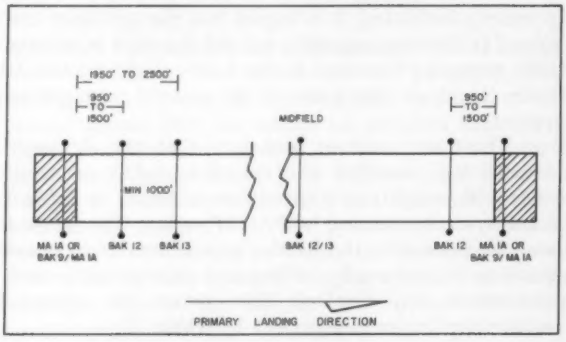

Table 1: Limitations of Various Arrestors.

TYPE	ENERGY ABSORBING CAPACITY	SPEED/WT LIMITATIONS	LENGTH OF RUNOUT	REWIND TIME
MA-1A	10-12 MILLION FT #	80K/ 43,000 #	1,000FT	4-6 HOURS
BAK-9	55 MILLION FT #	190K/ 40,000 #	950FT	5 MIN.
BAK-11/12	300 MILLION FT #	180K/140,000 #	2,000FT	5 MIN.
BAK-12	65 MILLION FT #	190K/ 40,000 #	950FT	4-5 MIN.
BAK-13	85 MILLION FT #	160K/ 40,000 #	950FT	1½ MIN.

A series of 250 new housing units for Air Force families is nearing completion in New Mexico. What follows is a report on the procurement method used.

One Step Turnkey Housing:

The Cannon Experience

by Maj R. Wayne Bateman and Thomas E. Lord, PE

Construction is nearing completion at Cannon AFB, New Mexico in the first of a series of new housing for Air Force families. The Cannon project will provide 224 duplex units for airmen and 26 single family officer units. The turnkey contract was awarded to Ecoscience, Inc. of Van Nuys, California, based on a competitive quality and price evaluation of the firm's design proposal.

The "one-step" turnkey procurement method used for the Cannon project was adapted from procedures normally used by the Air Force to buy weapon systems. The approach encourages homebuilders to offer housing to the Air Force that is similar to their commercial market housing. This new approach to turnkey housing was first used on a wide scale in the Fiscal Year 1972 program and is being applied extensively in FY 1973 and FY 1974.

The turnkey design and procurement process differs considerably from conventional architect-engineer design with a low-bid award. Builders submit designs to the Air Force based on site information and performance standards included in a "Request for Proposals" (RFP). These standards upgrade the widely-used FHA minimum property standards, and they permit a wide variety of design solutions. An Air Force Board of Professional Architects and Engineers evaluates the quality of designs proposed, without knowledge of firm identity, using a rating system outlined in RFP. The quality evaluation considers the subjective as well as quantifiable factors that affect livability. A separate Air Force selection board then compares quality ratings to proposed prices to determine which proposal offers the "best house for the money" within the funds available.

The Cannon project illustrates how turnkey's incentives to offer "more than the minimum" result in added livability for Air Force personnel. The airmen units, for example, are 13 percent larger than the minimum size specified in the RFP, with more than 1400 square feet of finished interior living area. The added space is readily visible in the living and family rooms and bedroom areas. The

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Brick and wood trim on stucco adds a "California look" to new Cannon AFB, New Mexico housing units which vary in floor plan and appearance.

The Cannon Experience

cont'd

units feature fully-equipped kitchens with disposals and dishwashers, central air conditioning, two baths and carports. Outdoors, the brick and wood trim on stucco adds a "California look" to units which vary in floor plan and appearance. Privacy fencing and landscaping give added livability to the covered patios. The brick and patio covers are specific examples of features that were not included in minimum requirements.

Tactical Air Command (TAC) experience in forming the evaluation team, developing procurement documents, evaluating proposals, and managing construction of the Cannon project may prove beneficial to other commands involved in turnkey housing.

Command Procurement Essential

TAC has found that central command procurement is essential to assure uniformity and equity in grading proposals. A central evaluation team of command personnel, supplemented by base representatives, assures that similar proposals submitted by a builder at more than one location are evaluated consistently. In addition, several hundred manhours are required to evaluate proposals and base organizations are not normally staffed for this added workload. Staff interference is minimized by placing professional personnel on special orders and removing them from their normal work place during the evaluation.

Good planning is required before issuing the RFP. The best way to encourage firms to submit proposals is to minimize the difficulties of proposing and to establish a reputation for professionalism and fairness. It is very important to limit the number of amendments to the RFP and to hold firm to an established schedule. The schedule should be realistic and should allow more time for preparing proposals than reviewing them. Specifications and site drawings should clearly define the project boundary and peculiar site conditions, such as utility tie-in points. Preferences for specific unit-types, such as single-story units or duplexes, must be indicated. Unacceptable building materials should be clearly identified, and if only certain building materials are acceptable, they should be specifically described. For example, if asphalt is not acceptable for sidewalks, this must be stated in the RFP. If concrete is the only acceptable material for sidewalks, this should be definite in the RFP. If project requirements are given careful thought before the RFP is issued, both the proposer and the Air Force will benefit.

Proposals are essentially concept submittals and should be reviewed as such. Evaluators must be experienced and knowledgeable in design and construction. They must be able to work well with people, have confidence in their ability to resolve problems, and be willing to compromise without sacrificing essential features. At TAC, the evaluation team follows the project through to final design and moni-

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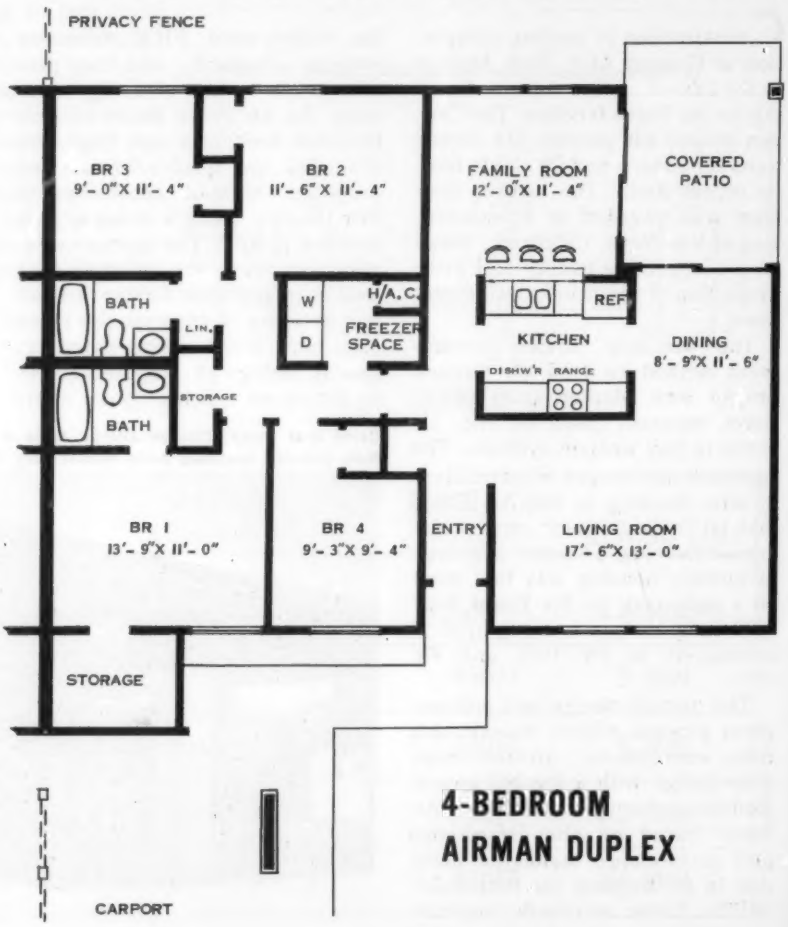

THOMAS LORD *is Chief, Architectural Division, Headquarters Tactical Air Command, Langley AFB, Virginia. A graduate of Pennsylvania State University with a bachelor's degree in electrical engineering and George Washington University with a master's degree in management, he is a registered Professional Engineer in Virginia.*

tors the actual construction. The feedback and experience is useful in evaluating future projects. In monitoring construction, establishing a rapport with the contracting officer and the contractor is essential.

Good inspection is paramount to a good project, regardless of procurement method. In turnkey, as any new concept, ambiguities exist. These ambiguities can be minimized by careful review of final drawings. A learning period, establishing procedures, and testing is necessary. Highly qualified and competent personnel are the key to success.

At Cannon AFB, the contractor was responsible for production and quality through his project superintendent and quality control team, with a project manager responsible for the overall project. Proper organizational and individual relationships between contractor and Government representatives are essential. Although production and quality are often at opposite ends of a spectrum, this dechotomy can be avoided through close coordination with the project superintendent and contractor's quality control representatives.

All personnel associated with the Cannon AFB project soon developed a sense of responsibility for both. To prevent confusion and delay, an informal atmosphere was agreed upon whereby the Government project officer and inspectors would bring problem areas and deficiencies to the attention of the contractor and subcontractor personnel. All deficiencies that could not be corrected "on the spot" became discussion and negotiation topics for the Government and contractor's project managers.

A procurement representative was present on the site throughout the first half of the construction period. This action proved exceptionally advantageous in that he was able to provide continuous guidance to inspectors and the contractor, thus facilitating timely arbitration of any dispute that might arise.

Exterior view of a new housing unit at Cannon AFB.

Inspection responsibilities were shared equally by contractor quality control personnel and Government inspectors. The inspectors reserved the right to disapproval, if a conflict arose. Some items required 100 percent inspection, such as subslab water, waste and vent system, slab grading and forming, stud wall framing, roof sheathing and concrete work. Other items such as placement of lath, plaster and drywall were inspected on a random basis by all inspection personnel, with close detailed inspection on each structure.

All technical testing was performed by an independent testing laboratory provided by the contractor, as required by the quality control plan, and the representative of this organization was permanently on the site during the period when testing, such as compaction, concrete asphalt paving, and other tasks requiring professional testing, was in progress. Reports of all such tests were provided to the project officer and provided an excellent means of monitoring and assuring quality.

Both production and quality of the project were monitored through the use of visual references, such as plot layouts depicting all the structures, and color coding or the use of colored pins to represent the status of tests or inspections that had been performed upon each structure. A visual progress board spanning the entire 500 day period was designed and wall mounted to provide ready reference on contract progress. Figures from weekly progress reports were transferred to this chart. Equipment specified by brand name or "equal" resulted in increased research on the part of the project engineer and inspectors to determine if "or equal" items did, in fact, meet the specifications of brand name items. The contractor's quality control representative can be very helpful in this regard, so it is most important to keep all channels of communication open.

Inspectors Referred to Plans

It is important to realize that project inspectors at Cannon AFB could refer to a complete set of plans and specifications, just as in a conventional project. Although in a turnkey project these documents are prepared by the contractor after award, they cover the building materials and construction methods used in considerable detail. The final plans must meet minimum RFP requirements and must reflect all proposal features exceeding minimums that are included in the contract; therefore, the drawings and data attached to the original contract must be available to **all** participants in the post award design review and construction phases. They are simpler than conventional plans and specs in the sense that they only cover materials and methods

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Editor's Note: A state of the arts on pre-treatment processes for industrial and domestic wastewaters is presented in the following paragraphs. This article covers one necessary ancilliary treatment device, and explains how the device removes scum and floatable solids from the water surface of a settling basin. The type used, depends on the configuration of the basin. Because of its mechanical operations, the unit is classified as a skimming device. Skimming has been and continues to be a popular adjunct in clarification processes for industrial and domestic waste treatment.

Skimming continues to be a popular adjunct in clarification processes for industrial and domestic waste treatments. It is a device that removes scum and floatable solids from the water surface of a settling basin. What follows is a guide on . . .

Removing Harmful Grease and Oils from Water Systems

by John L. Goforth, EIT

In waste treatment, suspended solids are removed by sedimentation and by skimming. Skimming consists of passing a mechanical or manual device over the surface to remove lighter than water solids which rise to the top. Numerous mechanical and chemical processes may be employed to increase the floatability of suspended solids.

A typical example of a skimming device is the radial arm attached to an overhead revolving truss on circular tanks. The arms travel over the tank surface pushing the floating material to the periphery where it is collected in a trough and piped to an outside sump. The system is valuable for removing a large percentage of grease, oils, and floatable solids that are present. This is important to assure effectiveness of secondary treatment processes, and to limit the suspended material in the plant effluent.

The basic need for skimmers is to remove the floating mass which occurs naturally or is the result of chemical or mechanical inducement on the surface of the liquid. This mass is commonly referred to as scum. By definition, scum is "a mass of sewage solids buoyed up by entrained gas, grease or other substance, which floats on the surface of the sewage." The concentration of grease and floating material in the waste, and the efficiency of pre-treatment facilities will determine the quantity of material requiring skimming. Scum is generally unsightly, odorous and releases fine suspended solids into the effluent as it decomposes.

Grease and oils can be found in all sewages. They may have adverse effects on piping systems, filters, biological treatment processes and downstream water quality. Grease includes fats, waxes, fatty acids, calcium and magnesium soaps, mineral oils and other non-fatty materials. Grease is extremely difficult to remove from the waste and has very little recovery value.

The increasing use of garbage grinders has increased the amount of skimmings by as much as 100 percent. The quantity of suspended solids is increased and a higher scum producing characteristic is realized. Other sources of skimmings can be found in trickling filters. The filter effluent may contain floating material as a result of filter sloughing. Also, fly larvae may be found in the filter effluent.

Floating material can be removed by hand skimming, mechanical devices or by a hydraulic system. Hand skimming is simply scooping the scum up with hand held devices made of perforated metal or fine meshed wire cloth. The scum may also be removed by trapping the material in a trough at the tank periphery which can be elevated by hand at one end to allow the scum to drain off and out of the system. Another manual process involves directing the skimmings into troughs by hoe and removal by pipe to a sump for further handling.

Various types of mechanical devices have been designed for removing scum. Probably the most common for the rectangular sedimentation tank is the continuous traveling flights powered by a small motor with chain assembly. Scum is collected in one end of the tank by the flights of the sludge-collecting mechanism in its return travel, **Figure 1.** The skimming blades or flights are constructed of most anything from wood to neoprene and are usually set about one-fourth of an inch below the water surface. As the flights move along the surface, they push the scum to the far end of the tank where it may be pushed into the scum trough by hand or mechanically by cross flight skimmers. Once in the trough, the skimmings are transmitted by water carriage to disposal facilities, or are recycled through an existing aeration tank. The skim-

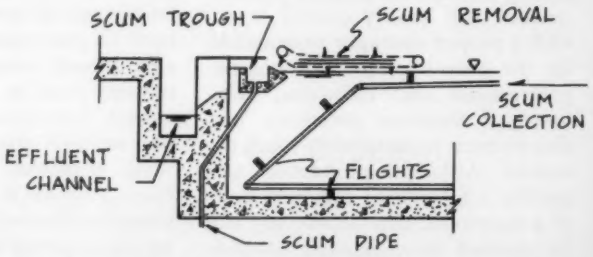

Figure 1: Sludge Collecting Mechanism.

mer return line can become clogged with grease or large solids. These stoppages are easily blown out by closing all lines except the skimmer pipes and actuating the air compressors.

Skimmers for circular tanks are usually designed as rotating arms supported and powered from the center island. The arms consist of an inner fixed blade with hinged outer blades that continuously transport the float to the tank periphery where it is automatically disposed of in scum troughs. The moisture content may be varied by the speed of rotation. The liquid level may be varied to obtain the proper depth in relation to the scum trough, and the skimmer blades may be adjusted to obtain optimum float collection. Blades are commonly made of steel with neoprene wipers. A typical skimmer arrangement in a circular tank is shown in **Figure 2.**

A clarifier is manufactured by a company which includes skimming equipment suspended from a rotating bridge. Included in the skimming package is a scum collection arm and a pneumatic scum ejector. The baffle, collection arm, scum ejection and influent well are all supported from the bridge and rotate with it. This unique feature makes it possible to operate the skimmer in severe climates with freezing temperatures. The normal scum collection system is supported from the truss and operates against a fixed scum baffle or trough. When freezing occurs in this type system, the mechanism must be shut down or disconnected from the truss so that the skimmer will not be damaged as it contacts the build-up of ice around the trough. One system is available which will continue to operate as long as enough flow is maintained to keep the areas between the scum baffle and weir free of ice. The ice formed will attach itself to the baffle, scraper arms supports, collection arms, and inlet well and will be rotated with the truss with no resulting structural damage.

Baffles Intercept Floatables

Another company advertises an exclusive non-mechanical, automatic surface skimmer which comes as standard equipment on all its packaged plants. Its advertisements state that all floating matter, including grease, is skimmed from the system by the device which has no moving parts or mechanical equipment and has no power requirements. The system consists of several parallel baffles which intercept the floatables as they are hydraulically driven into proper position.

Skimming plays a major role in the relatively new process of flotation. Flotation may be defined as the exact opposite of sedimentation. The system is designed to remove floatable material and solids with a specific gravity so nearly equal to water that they settle very slowly or not at all. The treatment converts dispersed suspended solids and grease to floating matter where it can be removed by the skimmers. The suspended matter is made floatable, utilizing air as the "floating agent." Air is introduced into the waste where the tiny air bubbles attach themselves to any suspended matter and float them, along with grease

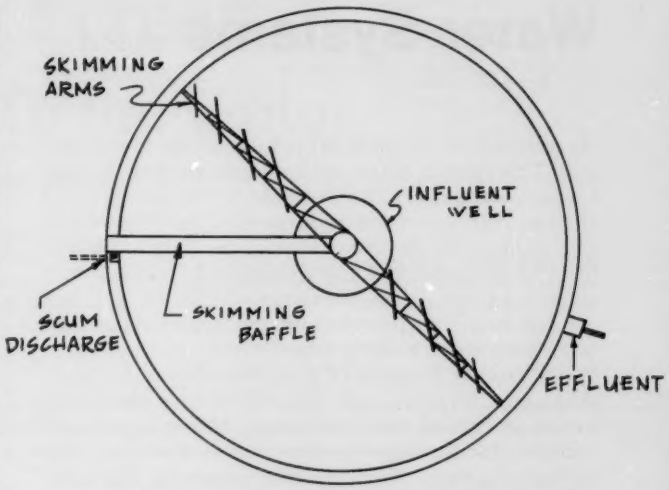

Figure 2: Typical Skimmer Arrangement for Circular Tank.

and oil, to the surface. A thick scum or float is thus formed on the surface and may be continuously skimmed off. The fact that the air bubbles cause the small solids to rise much faster than they would ordinarily settle allows shorter detention periods and a possible reduction in construction cost.

The flotation tank is usually circular in shape. The liquid waste enters the tank after being saturated with air in the preceding tank. When the floating matter is carried to the surface it is gathered by rotating skimmer blades and raked into discharge troughs. There are other more sophisticated variations available for floating the suspended particles. A popular system for industrial waste is the pressure-type unit. This method involves pressurizing the sewage and then releasing it to the atmosphere in the flotation tank. The super saturated liquid is filled with extremely fine bubbles that adhere to and lift the suspended particles into position for the skimmers.

The vacuum-type flotation unit is commonly used for floating grease and scum from sewage. After aeration, the sewage is placed under the partial vacuum, decreasing the soluability of the liquid. Thus, air is forced out of solution in the form of extremely fine bubbles and again carries the suspended material to the surface, creating a scum. Use of this can be expected to yield a suspended solids reduction of from 35 to 55 percent at a surface loading of 4000 to 6000 pounds per square foot, bod reductions from 17 to 35 percent and about 50 percent removal of grease.

One system is a covered cylindrical tank about 10 feet deep with a diameter of 13 to 60 feet and is maintained under a slight vacuum. As waste enters the tank, dissolved air is released and floats the suspended matter to be skimmed off.

Skimming tanks are very similar to the flotation system and are used primarily where large amounts of grease and oil can be expected in the waste. Air is introduced into the tank to bouyant and agglomerate

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Water Systems *cont'd*

the grease and oil which subsequently rise to the surface. This scum is drawn off from time to time through a trough and exits from a separate outlet. Compressed air is usually injected through porous plates or perforated piping. The detention time in the tank is usually five to 10 minutes, and approximately 0.1 cubic feet of air is used per gallon of sewage.

Scum is transported from the scum troughs by water carriage to a sump where it may be pumped to the digester or disposed of by incineration or burial. If skimmings contain much mineral oil they should be buried or burned with screenings. Skimmings are of special value for digestion purposes if there is a high content of grease. When added to anaerobic digesters, they will produce gas with much higher fuel values. However, grease removed from most domestic sewages has no recovery value because it is too contaminated with foreign materials for any use.

A very simple test is usually used to determine the volume of skimmings being produced in a particular system. Since normal sewage will yield from 0.1 to 6.0 cubic feet of skimmings per million gallons, departure from the values may indicate inefficiencies in the system or a plant effluent containing abnormal grease and oil concentrations. Small scum volume and high grease content in the plant effluent indicates air starvation in the flotation process.

The test simply involves taking a sample from flotation tanks, skimmer tanks, or settling tanks and allowing the sample to stand until the water and scum separate. Next the water is drawn off from the bottom and the volume of the scum is measured. Care must be taken not to allow gases to escape from the sample which will cause the scum to settle as sludge.

The use of a surface skimming device is but just one of the many pre-treatment processes which result in a better influent for the secondary processes. Skimmers do play an important role in that they provide an economical and effective means for removing harmful grease and oils from the system before they can harm equipment or affect later treatment. Skimmers used in conjunction with the flotation system can remove a good portion of the suspended solids. CE

JOHN GOFORTH *is a Project Engineer, Engineering Construction Branch, Eielson AFB, Alaska. He received his bachelor's degree in civil engineering from Tennessee Technological University. He is an Engineer-in-Training in Tennessee and is an associate member of the American Society of Civil Engineers.*

Brig Gen Frank G. Barnes, DCS/Civil Engineering, HQ AFLC, presents Kamenicky Award to Cadet Steven C. Boyce.

Civil Engineering Award Presented to Steven Boyce

2nd Lt Steven C. Boyce was awarded the Outstanding Cadet in Civil Engineering Award at the Air Force Academy 3 June 1974.

Following graduation, Lieutenant Boyce was assigned to the 62nd Civil Engineering Squadron, McChord AFB, Washington. As an undergraduate, Lieutenant Boyce was on the Dean's List for academic excellence for seven semesters, and for four semesters he was on the Superintendent's List for excellence in both academics and military training. He was a jumpmaster in the cadet parachute program and secretary of the Cadet Ethics Committee.

The Civil Engineering Award is presented in memory of 1st Lt George W. Kamenicky, a graduate of the Air Force Academy Class of 1969, by the civil engineering officers of the US Air Force.

After receiving his master's degree in civil engineering from the University of Illinois in 1970 and his pilot's wings in 1971, Lieutenant Kamenicky was assigned to the First Special Operations Squadron, Nakhon Phanom RTAFB, Thailand. While on a combat mission 30 September 1971, his A1E aircraft was hit by hostile ground fire and the Lieutenant was killed in the crash. Lt Kamenicky was posthumously awarded the Distinguished Flying Cross, the Air Medal and Purple Heart for the mission.

LETTERS
To the Editor

More Complete Removal of Pollutants

In his excellent article on "Eliminating Industrial Liquid Wastes," (November 1973, **Air Force Civil Engineer**) Mr (Robert) Keggan correctly identified four considerations to be evaluated in the discharge of industrial wastewaters to sanitary sewers. However, he may have overlooked a fifth consideration which should be made to ensure protection of the environment.

That consideration is on the environmental impact of certain materials which are at sufficiently (legally) low concentrations in the sewage plant effluent. Depending on the nature of the waterway into which the effluent is discharged, these materials may adversely effect the biota in the waterway. Assume a hypothetical sewage plant which processes air station industrial as well as municipal wastes and discharges into a narrow tidal creek. If the tidal flushing in the creek is not of great dimension, such materials as heavy metals may become concentrated in the sediments and in the organisms inhabiting the tidal creek and its associated salt marsh. In a locale such as the Chesapeake Bay, this may result in eventual pollution of harvestable organisms such as oysters, and thus, loss of a commercial item. Even mobile organisms, such as crabs and fish may be adversely affected and lost, especially the immature forms which spend the early part of their life in the marsh.

While the article was of great moment to persons involved in pollution control at military air facilities, failure to consider the effect of the liquid waste once it goes through the treatment plant is myopic. The civil engineer must become more aware of all the consequences of his actions. Merely to process the waste and send it diluted into an **off-station** ecosystem is not sufficient to adequately protect the environment. We must look to more complete removal of the pollutant at its source as the ultimate solution.

JAMES A. BRADY, Lieutenant, USN
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"Got a Better Idea?"

"What we lack here is a means of communication." Sound familiar? Let's fill the gap. "The Letters to the Editor Department" is the only way the **Air Force Civil Engineer** has of knowing how you feel about it.

Are you satisfied? Why not write us? Remember, your words make our job just a little easier.

Editor's Note: Lieutenant Brady's letter was reviewed by Mr Keggan and his response is as follows:

True, non-biodegradable toxic pollutants can build up in bottom sediments to the detriment of biota in receiving waters. Consideration of this fact by those setting water quality and discharge limit standards is leading to increasingly more stringent standards. However, the subject of the article was the collection, treatment and disposal of industrial wastes, rather than a treatise on the chronic effects of pollutants on water life or a discussion on the proper establishment of water quality law. For this reason, references to specific treatment efficiencies or numerical effluent loadings were avoided. No inference was meant that only the "legal" discharge limits need be met. Therefore, I submit that the fourth consideration, Will The Treatment Facilities Provide Adequate Pollutant Removals?, covers Lt. Brady's concern, provided all factors are considered in determining the desired effluent quality. Therefore, the article was not "Short-Sighted," possibly just short. However, we both agree, "Dilution is no solution to pollution!"

ROBERT E. KEGGAN
HQ Air Force Logistics Command
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The Cannon Experience *cont'd*

proposed by the builder, rather than a wide range of alternatives described in generic terms. This does not mean, as often claimed, that materials or workmanship will be inferior in turnkey projects. A prototype house is constructed before production work begins to insure that plans and specifications are realized.

In both design and construction, there are distinct advantages to one-step turnkey procurement. It minimizes the engineering and design efforts required by the Government. Perhaps more importantly, it uses the expertise and learning curve of specialized contractor design and construction personnel, and it permits reuse of structural and installation techniques learned on previous projects. It insures an intimate knowledge of design drawings and specifications by contractor personnel. Perhaps one of the most important advantages, during this period of material shortages, is that the contractor can specify by brand name the equipment and hardware items he is reasonably sure will be available.

Although few disadvantages of the turnkey concept are evident, it may require more effort on the part of Government representatives and inspectors in insuring that "or equal" equipment meets the specification of "by name" proposed equipment. There may be more interpretation by the inspectors and closer coordination with the contractor to insure that good trade practices and local area practices are followed. Therefore, experienced and qualified inspectors are a key to project success.

Above all, remember that the biggest factor in success of a project of this nature is people. There must be constant and close coordination between the contractor's project manager, his quality control, the Government project engineers and inspectors and the contracting officer. The informal atmosphere created by this coordination can result in better production and a better product.

In summary, with a comprehensive RFP, thorough review of proposals and plans and specifications, and coordination and cooperation between contractor and Government representatives throughout the design and construction, turnkey is an excellent housing construction procurement technique. TAC is getting more for the dollar under turnkey than it ever has under the conventional approach.

CE

XENIA TORNADO DISASTER

Civil Engineers Lend a Helping Hand . . .

Civil engineering personnel from the Air Force were called once again to assist in recovery operations following a natural disaster after the largest tornado ever recorded in Ohio history wiped out 30 to 40 percent of the buildings and homes in the city of Xenia on 3 April 1974. Their assistance and that of other Air Force personnel such as medical, airlift and a host of volunteers who helped in whatever manner possible, demonstrated again that the Air Force always extends a helping hand when called upon.

The tornado, with winds estimated at 318 miles per hour at its center, traveled at 48 miles per hour on its course of death and destruction through the city. It smashed its way through a residential area on the southwestern edge of the community of over 25,000 people, continued on through the heart of the downtown area, bounced on its way through the northeastern section of the city and finally fizzled out after ravaging the campus areas of Central State University and Wilberforce University.

When it was all over, 32 persons were dead, well over 500 persons were injured and damage losses to property were set at $100 million. Even though 223 military and 1,064 civilian employees of Wright-Patterson AFB live in Xenia, no deaths occurred among base personnel and only minor injuries were sustained by one military and five civilians. Homes of 293 employees were destroyed or damaged, 275 belonging to civilian and 18 to military members.

Within an hour after the tornado struck at 1640 hours, civil engineering personnel from the base, approximately 10 miles northwest of Xenia, and members of the 820th Civil Engineering Squadron (RED HORSE), from Nellis AFB, Nevada, were assembled and briefed. (The RED HORSE squardron had been working on facilities demolition at the base.) An hour later, they proceeded in a convoy of 23 pieces of heavy equipment and vehicles to the stricken area. Shortly thereafter, a second convoy followed with bulldozers and dump trucks. Five tow vehicles with generators and flood lights were also sent to the scene.

A flag blows in the breeze at the site of what had been a large supermarket near the downtown area of Xenia.

All materials and personnel were directed to locations determined by the On Scene Commander and coordinated through the Disaster Preparedness Control

A couple stops to view the remains of an older housing area in Xenia the day after the tornado struck.

Center at the base. The Control Center was headed by Brig Gen Irby B. Jarvis, Base Commander, Wright-Patterson AFB. Upon arrival in the city, personnel immediately began recovery operations. They included:

- Assisting railroad crews in the clearing of derailed railroad boxcars which were blown over when a freight train was passing through the city at the time the tornado struck. The box cars blocked a major east-west thoroughfare through the city.
- Repair of overhead utility power lines and assistance in restoring power and water lines.
- Operation and maintenance of emergency generators.
- Search and rescue operations for the dead and injured.
- Clean up and disposal of all forms of debris.

Three and one half days later, most civil engineering personnel were relieved and only a few personnel and some items of equipment remained on the scene. CE

Upturned roots and downtrodden limbs marr this residential area. Air Force personnel aided in the cleanup.

Air Force personnel from Wright-Patterson AFB helped clear a residential street of fallen trees and other debris.

Goddard Award Presented for First Time by SAME

GODDARD MEDAL
G. H. Goddard SMSgt K. L. Frazier

Air Force Civil Engineers were the recipients of coveted awards presented by the Society of American Military Engineers (SAME) during its 54th Annual Meeting at the Rice Hotel in Houston, Texas in May.

A highlight of the award presentations was the naming of the first winner of the Guy H. Goddard Medal.

SMSgt Kenneth L. Frazier, Jr., North American Air Defense Command Cheyenne Mountain Complex, Prime Power Plant Superintendent, 4604th Aerospace Support Squadron, Ent AFB, Colorado, accepted the plaque from Maj Gen Guy H. Goddard, US Air Force (Ret). General Goddard is a past president of the SAME and a former Director of Air Force Civil Engineering.

Sergeant Frazier distinguished himself during 1973 by contributing directly to the Aerospace Defense Command's mission by providing exceptional technological guidance and techniques in identifying and solving problems affecting the mission.

The award, which will be presented on an annual basis, honors an active duty enlisted member of Air Force Civil Engineering in recognition of outstanding contributions to military troop construction and/or base maintenance by demonstrated technical and leadership ability.

Other award winners included:

• **Col Luis F. Dominguez, Base Civil Engineer, U-Tapao AFB, Thailand: Newman Medal for 1973.** He was cited for outstanding contributions to military engineering throughout his Air Force career. The SAME citation read: "Whether as an instructor, research or staff officer, or base civil engineer, he has demonstrated outstanding initiative, leadership and ingenuity in accomplishing varied and complex engineering requirements. His engineering ability has enhanced the image of civil engineering in both the military and civilian communities."

Colonel Dominguez accepted the award from Brig Gen William T. Meredith, US Air Force (Ret).

The Newman Medal, named in memory of Maj Gen James B. Newman, Jr, a past president of the Society and a past Director of Installations, Headquarters US Air Force, is offered as an annual award to a member of Air Force Civil Engineering for the most outstanding contribution to military engineering through achievement in design, construction, administration, research or development.

NEWMAN MEDAL
W. T. Meredith Col L. F. Dominguez

CURTIN PLAQUE
Maj Gen McGarvey Col G. C. Tuttle

• **317th Civil Engineering Squadron, Pope AFB, North Carolina: The Curtin Plaque for 1973.** Under the command of Lt Col George G. Tuttie, the Squadron was recognized for its distinguished and outstanding mission accomplishment, managerial improvements, and economic use of resources.

The Curtin Plaque is given on an annual basis by the Society to the unit within Air Force Civil Engineering selected as the most outstanding during the calendar year. It is named for Maj Gen Robert H. Curtin, US Air Force (Ret), a past president of the SAME and a former Director of Air Force Civil Engineering.

Colonel Tuttle accepted the award for the Squadron from Maj Gen Billie J. McGarvey, current Director of Air Force Civil Engineering.

In other business, General McGarvey and Richard A. Beauvis, Deputy, Base Civil Engineering, Kelly AFB, Texas, were elected to the Board of Directors of the Society.

U.S. GOVERNMENT PRINTING OFFICE: 1974—758-608/4